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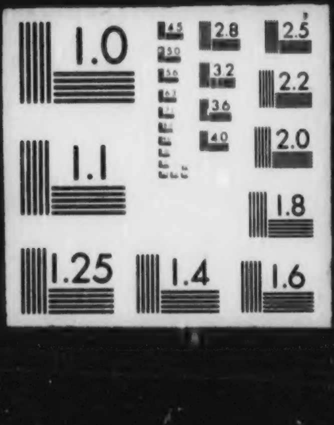
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PB-237 952

EPA RESPONSE TO REMAND ORDERED BY U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA IN PORTLAND CEMENT ASSOCIATION V. RUCKELSHAUS (486 F. 2ND 375, JUNE 29, 1973)

Environmental Protection Agency
Research Triangle Park, North Carolina

November 1974

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16. ABSTRACT

On June 29, 1973, the U.S. Court of Appeals for the District of Columbia remanded to EPA the standards of performance for Portland cement plants promulgated under section 111 of the Clean Air Act, directing the Agency to reconsider the standards and provide additional explanation of the action taken. EPA has reviewed the standards for these plants pursuant to the remand and has concluded that the standards other than the opacity standard should not be revised. This document is a detailed technical justification and explanation of the actions taken by the Administrator in promulgating the standards for Portland cement plants. Included is the justification for revising the opacity standard.

17. KEY WORDS AND DOCUMENT ANALYSIS

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ERRATA FOR EPA-450/2-74-023

EPA RESPONSE TO REMAND ORDERED BY U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA IN PORTLANT CEMENT ASSOCIATION V. RUCKELSHAUS (486 F. 2d 375, JUNE 29, 1973)

1. Insert the attached page after the last page of Appendix II (p. 82).

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ERRATA FOR EPA-450/2-74-023

EPA RESPONSE TO REMAND ORDERED BY U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA IN PORTLANT CEMENT ASSOCIATION V. RUCKELSHAUS (486 F. 2d 375, JUNE 29, 1973)

REFERENCES FOR APPENDIX II

1. State of Maryland, 43PO4 regulations governing the control of air pollution in area III (as amended through December 23, 1971).

2. The Cement Industry - Economic Impact of Pollution Control Costs, Boston Consulting Group, November 1971, Vol. 1, p. 11.

3. Emission Testing Report, United Cement Company, Artesia, Mississippi, kiln, wet process, electrical precipitator, tested by company personnel, 1974.

4. Emission Testing Report, United Cement Company, Artesia, Mississippi, clinker cooler, cyclone and wet scrubber, tested by company personnel, 1974.

5. Emission Testing Report, Santee Portland Cement Corporation, Holly Hill, South Carolina, kiln No. 2, wet process, two electrical precipitators, tested by Pollution Control-Walther, Inc., 1974.

6. Emission Testing Report, Monarch Cement Company, Humboldt, Kansas, kiln, dry process and clinker cooler, two baghouses, tested by the Fuller Company, 1974.

7. Memorandum from Roger T. Shigehara and Clyde E. Riley to Robert T. Walsh, dated April 23, 1974, corrected July 26, 1974.

8. Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Cement Manufacturing Category, U.S. Environmental Protection Agency, EPA-440/1-74-005-a, 1974.

EPA-450/2-74-023

EPA RESPONSE TO REMAND ORDERED BY U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA IN PORTLAND CEMENT ASSOCIATION V. RUCKELSHAUS (486 F. 2d 375, JUNE 29, 1973)

Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

November 1974

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Publication No. EPA-450/2-74-023

EPA Response to Remand Ordered by U. S. Court of Appeals for the District of Columbia in Portland Cement Association v. Ruckelshaus (486 F.2d 375, June 29, 1973)

On June 29, 1973, the U. S. Court of Appeals for the District of Columbia remanded to EPA the new source performance standards for Portland cement plants (40 C.F.R. 60.60 *et seq.*) promulgated by EPA under §111 of the Clean Air Act. EPA has reviewed its standards for these plants pursuant to the remand and has concluded that the standards other than the opacity standard should not be revised.

The bases for these standards are set forth in full below. This description of the bases for the standards responds to concerns expressed by the Court in its opinion explaining the bases for the remand. In order to assure that all of the Court's concerns are addressed, Appendix I is provided which lists the questions raised by the Court and EPA's responses to these questions.

EPA sought and received comments from the public and the affected industry in developing the challenged standards prior to proposal and during the proposal period prior to promulgation. Criticisms of these standards were again raised by petitioners and intervenors in connection with the legal challenge to these standards and were also carefully reviewed. EPA has, of course, carefully considered the comments as well as the order of the U.S. Court of Appeals for the District of Columbia Circuit in responding to this remand. However, to further insure that the affected industries had an opportunity to comment on EPA's response to the remand and to insure that a reviewing court would have the benefit of EPA's response to such comments, a proposed remand response was submitted for comment to the petitioner and intervenors in this case.

At the request of Appalachian Power Co. and Essex Chemical Corporation, petitioners in another case in which new source performance standards were remanded, Essex Chemical Corp. v. EPA and Appalachian Power Co. v. EPA, 486 F.2d 427 (C.A.D.C. 1973), copies of the remand response were also submitted to these companies for comment. The remanded issues in the latter decision included an issue raised in this case, i.e. reliability of opacity readings, and EPA believed it appropriate to obtain the comments of these companies with respect to this issue. Comments were received from both companies.

The comments received were carefully reviewed and have persuaded the agency that no revision should be made to the standards other than the opacity standard. Because it was not found necessary or desirable to revise the standards in any other respect as a result of the comments received, the proposed response as submitted to petitioners is set forth as a final response. (Minor corrections have been made to the text of the response on pages 8, 26, and 39.) The comments received with respect to issues other than opacity and EPA's response to these comments are set forth in Appendix II. Because substantial revisions were deemed necessary to EPA's draft remand response on the issue of opacity, EPA's discussion of opacity and justification for the revised opacity standard are set forth in full in Appendix III of this response.

Copies of documents referenced herein are available from Emission Standards and Engineering Division, Environmental Protection Agency, Research Triangle Park, North Carolina 27711, Attention: Mr. Don R. Goodwin.

November 1, 1974
Date

John Quarles
Acting Administrator

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HISTORY OF CONTROL TECHNIQUES

Prior to December 1970 when the Clean Air Act was amended, EPA and its predecessor agencies had acquired extensive knowledge of portland cement operations. A study of the industry had been made by the U. S. Department of Health, Education, and Welfare and in 1967 a report was published entitled, "Atmospheric Emissions from the Manufacture of Portland Cement", PHS Publication No. 999-AP-17.[1/] Engineers from EPA's predecessor agencies had inspected numerous plants and discussed control technology with vendors and knowledgeable individuals within the cement industry and had provided technical assistance to State and local air pollution control agencies regarding air pollution problems associated with cement plants. Further information regarding cement plants was developed by EPA engineers for publications concerning cement plant control technology, e.g., AP-51, "Control Techniques for Particulate Air Pollutants", 1969.[2/] In addition, a report dated September 30, 1970, relating to the establishment of national emission standards for portland cement manufacturing plants had been prepared under contract by the Research Triangle Institute and Pedco-Environmental, Incorporated.[3/]

These references were used to obtain general knowledge of cement plant operation, control and nature and quantity of emissions. They were also used for their enumeration of cement plants in the United States.

It was recognized that at portland cement plants, there are several sources of dust, with some more difficult and more costly to control than others. Kilns were recognized as the most difficult and costly to control. Exhaust gases from kilns are hot, contain heavy concentrations of very fine dust, and often large fractions of water vapor. Clinker coolers which are used to cool the product from the kiln were considered easier to control because they contain more coarse particulates and less moisture. Other equipment in cement plants was generally operated at ambient temperature, and therefore easier to control. For instance, grinders and conveyors often produced heavy concentrations of very fine particulates, but since this dust is handled at room temperature, it can be collected in fabric filters or baghouses which the cement industry acknowledged to be extremely effective in controlling dust.

For those sources operated at ambient temperature, there has never been an argument with the cement industry as to how they should be controlled. The industry acknowledged that baghouses were the most effective devices and since they collected a larger fraction of their product--cement--than any other available device, the industry readily used such devices. In the case of clinker coolers, many cement plants had used only centrifugal collectors to remove the coarse particulate from exhaust gases. However, in 1970, it was observed that several plants were installing more effective devices, usually electrostatic precipitators or baghouses. EPA observations indicated that both electrostatic precipitators and baghouses appeared to be effective in controlling particulate emissions.

In the case of cement kilns, by 1970 industry had generally supplemented centrifugal collectors with electrostatic precipitators or baghouses. (Centrifugal collectors are not capable of collecting the very fine particulates that are released from the kilns and would not therefore be acceptable in most communities in the United States.) There are many more kilns in the United States equipped with precipitators than with baghouses but baghouses have been applied to both wet and dry process kilns. Precipitators can be designed to achieve extremely high efficiencies but the higher the efficiency the more costly the unit.

Because precipitators can be purchased which will operate over a range of efficiencies, plant operators that wished to control emissions but not necessarily to the high efficiency that baghouses achieve generally selected lower efficiency, and thus lower cost, precipitators, As public pressure and local regulations caused plant operators to install higher efficiency equipment, more plant operators chose to install baghouses. The best controlled kilns observed and tested by EPA were controlled by baghouses. Later data which will be discussed below show that precipitator controlled plants can also meet the standards.

COMPARISON OF WET PROCESS AND DRY PROCESS EMISSION CONTROLS

Both precipitators and baghouses are used on wet process as well as dry process kilns. The only difference between controlling emissions from the two processes is that the gases from the wet process kiln contain 25-40 percent moisture by volume whereas those from a dry process kiln contain less than 5 percent moisture. At one time, plant operators feared that this additional moisture would clog bags and cause shutdowns. It was also feared that baghouses could not be used on wet process plants in cold climates because of condensation. This apprehension is why there are fewer baghouses on wet process plants than on dry process plants. However, at actual installations these problems have been resolved by insulating and if necessary heating the exhaust emissions to keep the moisture from condensing. There are presently wet process plants with baghouses operating successfully in such cold and moist climates as Thomaston, Maine (Dragon Cement Company), Lake Oswego, Oregon (Oregon Portland Cement Company), and Northampton, Pennsylvania (Universal Atlas Company).

The existence of the greater moisture content in wet process gases means that a greater volume of emissions must be controlled at such plants. Thus, controlling emissions from wet process kilns will cost more, both for heating and insulation as well as treating the additional volume of gases, than will controlling emissions from dry process plants. The cost of insulating a wet process baghouse or precipitator would depend on the external temperature range. Nevertheless, the differential cost of insulating a wet as opposed to a dry process plant is not significant compared to other dust control costs.

The greater volume of gas from a wet process plant requires an equivalent increase in baghouse or precipitator size. For a 10,000 bbl per day plant, the cost of a wet process baghouse would be approximately $890,000 as opposed to approximately $730,000 for a dry process baghouse. Corresponding costs for an electrostatic precipitator are estimated as $750,000 and $650,000 for wet and dry process plants, respectively.[4/]

However, these additional costs for a wet process plant are largely offset by the fact that a wet process plant does not need to control emissions from the grinding process before the raw material is put in the kilns. This emission control equipment for a 10,000 bbl a day dry process plant costs approximately $90,000[4/].

Achieving the same mass particulate limit per ton of cement produced is more difficult for a wet process plant than a dry process plant because of the greater volume of emissions and because of inherent limitations of dust collectors. Baghouses and precipitators can only reduce concentrations of particulates of gas emissions down to certain levels. Since wet process kilns emit greater volumes of gas than dry process kilns of equivalent size, a given concentration of particulates emitted will result in a greater total amount of particulates being emitted from a wet process kiln per unit of cement produced.

For example, if a baghouse or precipitator can reduce concentrations of particulates down to a certain number of grains per actual cubic foot of gas emitted, the total emissions of particulates from a wet process plant per unit of cement produced will be 25-40 percent higher than the total emissions of particulates from a dry process plant because of the 25-40 percent greater volume of gases which wet process plants emit. Thus, the highest level of particulate control, expressed in pounds per ton of dry feed, which a wet process plant can achieve would result in about 25-40 percent more emissions than that from a dry process plant. As will be discussed later, EPA took this into account in setting the standard.

TESTING

While EPA was knowledgeable in 1970 regarding applicable control devices for cement plants, they possessed very little source test information with regard to the emission of particulates from cement plants. Most of the test data had been collected using the American Society of Mechanical Engineers (ASME) Power Test Code. This is considerably less specific and as a result different from the EPA particulate sampling method which had been utilized to a large degree with incinerators and combustion sources.[a/] It was recognized that an appreciable effort would be required to survey and select plants demonstrating best control technology and to evaluate the emissions from these sources using the EPA particulate sampling method.

Early in 1971, EPA engineers contacted the Portland Cement Association, the Bureau of Mines, and knowledgeable vendors of air pollution control equipment. They procured pertinent information regarding what appeared to be the better controlled plants and arranged inspection tours to evaluate the apparent efficiency of the air pollution control equipment at various plants. During these inspections, EPA engineers observed that those plants--both dry and wet process--equipped with baghouses appeared to operate with less particulate emissions than did those plants at which

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[a/] The ASME code is broadly defined such that it covers several techniques including even the EPA method with and without impingers. However, most ASME tests have been conducted with a different filter and under different conditions than EPA Method 5 such that results are not normally comparable to the EPA method.

the kilns were equipped with precipitators. Nevertheless, some precipitator-equipped kilns also exhibited what appeared to be good control of particulates. The basis for the initial judgment of the effectiveness of control was the amount of visible emissions emanating from stacks and leaks in ductwork, etc., as well as observation of the quantity of dust deposited on surfaces of roofs, floors, equipment, etc., within the plant. Four plants were inspected where kilns equipped with baghouses had minimum dust emissions and appeared to be operated in an extremely clean manner. These four plants were operated by Ideal Cement at Tijeras, New Mexico; Dragon Cement at Northampton, Pennsylvania; Oregon Portland Cement at Lake Oswego, Oregon; and Coplay Cement Company at Nazareth, Pennsylvania. There were four plants where kilns equipped with precipitators also appeared to be well operated and with minimum dust emissions. These kilns were at plants operated by the Ideal Cement Company in Seattle, Washington; the Maule Industries plant at Hialeah, Florida; the Lone Star Cement plant at Greencastle, Indiana; and the Ideal Cement plant at Castle Hayne, North Carolina. Cement plants equipped with both types of control devices were observed which exhibited heavy concentrations of dust in and around the buildings and in the gases being discharged from stacks serving the kilns. The latter instances appeared to be the result of inadequate maintenance and/or dust collection equipment deficiencies.

As a result of plant visits, EPA selected plants for its testing program of kilns, clinker coolers, and finish mills. Five kiln installations were tested as well as three clinker coolers, one raw mill, and three finish mills. These included a wet process kiln with a baghouse at Harleyville, South Carolina which appeared to be so poorly maintained that results would be questionsable. Nevertheless, with the time constraints in the Clean Air Act, it was deemed necessary to test these installations to gather information for setting our standards. It is emphasized that the selection of test sites was a compromise between what appeared to be best available control and the ability to conduct representative source tests. Four plants had to be discounted because the kiln control devices were not constructed in a manner that would allow them to be tested. These were the Ideal Cement Company in Tijeras, New Mexico; the Universal Atlas plant in Northhampton, Pennsylvania; the Lone Star Cement Company in Greencastle, Indiana; and the Coplay Cement Company in Nazareth, Pennsylvania. These included open discharge baghouses and precipitators in which the configuration of the ductwork made testing impossible. The kilns that were tested before proposal were operated by Dragon Cement Company in Northampton, Pennsylvania (dry process with baghouse, Emission Testing Report ETB Test Number 71-MM-05)[5/]; by Ideal Cement Company in Seattle, Washington (wet process with precipitator, ETB Test Number 71-MM-03)[6/]; by Maule Industries in Hialeah, Florida (wet process with precipitator, ETB Test Number 71-MM-01)[7/];

and by Giant Portland Cement in Harleyville, South Carolina (wet process with baghouse, ETB Test Number 71-MM-07).[8]

The test data obtained from these kilns include the amount of particulates collected in both the front half and the back half of the EPA sampling train. At the time EPA proposed these standards, it was anticipated that compliance with the standards would be determined by measuring particulates captured in the total train (front half plus the back half of the sampling train). However, the standard as promulgated requires that compliance be determined by measuring only the particulates collected in the front half of the train. This change in sampling techniques required for compliance in no way brings the test data into question since EPA obtained data on the catch in the front half of the train. The only effect of the change is that back half test results are no longer used for compliance purposes. All particulate emission data referred to in this Notice refers to the front half catch unless otherwise noted.

The test results for the four plants showed the following averages:

Dragon Cement Company	0.07 lbs/ton
Ideal Cement Company	0.88 lbs/ton

Maule Industries	1.15 lbs/ton
Giant Portland Cement	0.52 lbs/ton

As these results show, the Dragon Cement dry process kiln equipped with a baghouse was operating well below the standard[b/] but none of the other three plants, all of which were wet process operations, met the eventual limit of .3 pound of particulate per ton of feed. However, the control devices on these plants did not appear to be operating at optimum effectiveness during the test period. For example, the baghouse at the Giant Portland Cement Company plant in Harleyville, South Carolina was actually a 24-compartment unit with 12 separate stacks. EPA tested each of the 12 stacks and averaged the results. Results showed emissions well in excess of the proposed standard; however, visible emissions from some stacks looked better than others indicating that the bags in some of the compartments were in better condition than in others. There was considerable evidence of poor maintenance in that dust was observed on the roof of the baghouse and on other horizontal surfaces in proximity to the baghouse discharges.

Taking into account that the only difference between the emissions of wet and dry process plants is the higher moisture content of the wet process emissions, EPA estimated

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[b/] Subsequent to the EPA tests, the plant operators conducted comparison tests using a somewhat different test procedure. Results were similar, averaging 7 percent lower than EPA measurements. The company, Martin Marietta Cement, has stated that they believe the two test procedures give the same results and requested that EPA certify its particulate test meth equivalent to Method 5. No action was taken on the request because EPA had not established guidelines for determining equivalency and felt that more comparative testing was needed before the method could be deemed equivalent.

from the dry process test that wet process plants could achieve the standard by a reasonable margin. The Dragon test showed that particulate concentrations in gases could be controlled to approximately .005 grains per actual cubic foot of air emitted. If the volume of air emitted from a wet process kiln were 40% greater per ton of feed due to greater moisture content, the same concentration, .005 grains per actual cubic foot of air emitted, would result in 40% more pounds of particulate per ton of feed or, based on the Dragon test, would be about 0.1 pounds per ton of feed. This would be well below the standard.

Although it was EPA's judgment based on this estimate and statements of control equipment vendors that wet as well as dry process plants could be controlled to meet the standards, EPA decided to conduct another test on a wet process plant. A wet process kiln equipped with a baghouse at the Oregon Portland Cement installation at Lake Oswego, Oregon, was selected and a test was run in August of 1971[9/] shortly after the standards were proposed. During the test, it was observed that there were visible emissions from the stack at somewhat greater opacities than had been observed during the initial inspection. The process was upset during testing and EPA engineers believe that bags were broken. Subsequent evaluation of the data showed that emissions were considerably greater than emissions from the Dragon Cement Company--averaging .60 pound per ton of feed. Discussions were held with company personnel and it was agreed that efforts would be made to repair the system such that it would operate in a more representative manner. Such repairs were made although it must be emphasized that the repairs were still not of the type that would be considered good operating and maintenance practice. In most instances, the broken bags were merely blocked or tied off in the system such that they no longer served as filter media. The EPA engineer supervising the test estimated 15 percent of the bags were tied off during the test. This effectively removed some of the fabric filter area from the system and meant that the remaining bags were required to perform the task that the entire baghouse would perform under well maintained conditions. This decreased filter area tended to cause greater wear on the bags and could have resulted in greater particulate emissions. Nevertheless, tests on this plant were run in October of 1971, which showed average emissions of 0.28 lbs/ton (Emission Testing Report ETB Test Number 71-MM-15).[9] Thus, at the time EPA promulgated the standard both a wet and a dry process plant had shown in tests that they could meet the standard.

Since the standard was promulgated, summary test data on other Portland cement plant kilns have been obtained by EPA from a State air pollution control agency. One test was conducted by a private testing firm commissioned by the plant operator and the other test was conducted by plant personnel. The data may be obtained from EPA. They show the following:

Test Date	Name of Company	Emissions in lbs/ton of dry feed
4/18-25/72	Lehigh Portland Cement Company, Union Bridge, Md., dry process, electrical precipitator [10]	0.125
7/11-14/73	Marquette Cement Manufacturing Company, Hagerstown, Md., dry process, electrical precipitator [11]	0.087

Thus, two additional portland cement plant kilns appear capable of meeting the standard. To date, therefore, both a wet and dry process plant using a baghouse have been shown by EPA tests to have achieved the standard and data submitted to a State air pollution control agency indicates that two additional dry process plants using precipitators have achieved the standard.

The EPA tests which showed emissions above the standard do not show that those sources could not meet the standard. They only showed that they were not meeting it when tested, whether due to inadequate maintenance, inadequate control equipment, temporary upset, or some other reason.

CONTROL EQUIPMENT VENDOR STATEMENTS

Control equipment vendors have stated that their equipment will permit the attainment of the standards. Mr. T. A. Brown of the Koppers Company in a letter to EPA dated September 30, 1971, said that he saw no problem meeting the standard with electrostatic precipitators. Wheelabrator-Frye in a letter dated April 7, 1972, said it would guarantee Medusa Portland Cement Company that its precipitators and baghouses would limit emissions below the standard. Buell Environ-tech in a letter dated May 10, 1972, and Kaiser Engineers in a letter dated May 10, 1972, said their precipitators would limit emissions from wet process plants to the standard.

EPA believes that these statements are useful supplementary evidence confirming that the standards can be met. While considerations of self interest could lead a control equipment vendor to advocate a stringent standard, it would be contrary to the self-interest of such a vendor to represent that his equipment could meet the standard if it could not. It would be especially contrary to the self-interest of the vendor to represent or guarantee to a potential purchaser of his equipment that it could meet the standard since the vendor would be liable for failure to satisfy his obligations. Furthermore, all of these vendors have good reputations and they would not have achieved nor could they maintain their reputations if they misrepresented the capability of their equipment. Because of these factors and because the vendor statements supplement the source tests rather than serve as a sole basis for the standard, EPA believes that the expenditure of time and resources needed to independently verify the vendors' statements is not warranted.

One of the factors which several of the vendors and many cement plant operators expressed doubt about was whether the standard could be met at all times including periods of startup, shutdown, and upset. EPA has promulgated regulations which make it clear that EPA's mass emission limits apply only during performance tests rather than at all times. The standards do not apply during periods of startup, shutdown, and malfunction. (38 F.R. 25864, October 15, 1973).

OPACITY STANDARD

EPA promulgated opacity limits as well as mass emission limits because opacity limits provide an effective and easily utilized means of determining relative mass emissions as well as wether control equipment is being properly maintained and operated. EPA personnel observed during testing that two plants which met the mass emission standard did not exceed 10 percent opacity during emission test periods.

An additional cement kiln was observed that had no visible emissions, but it could not be tested for mass emissions due to physical limitations. A summary of mass particulate emissions and observed opacities for cement kilns investigated by EPA is shown in Table 1.

Table 1. PARTICULATE MATTER AND OPACITY OF EMISSIONS FROM CEMENT KILNS

Cement Plant	Measured Particulate Emissions, lbs/ton feed, from kiln	Opacity of Visible Emissions, %, from kiln
Dragon Cement Company Northhampton, Pa.	0.0705	5 - 10
Oregon Portland Cement Lake Oswego, Oregon		
Test No. 1, August 1971	0.56	10 - 30
Test No. 2, October 1971	0.272	0 - 10
Giant Portland Cement Harleyville, S. C.	0.574	0 - 35
Ideal Cement Company Seattle, Washington	0.883	20
Ideal Cement Company Tijeras, New Mexico	---	0

EPA has given adequate consideration to the problems of measuring opacity by use of the trained and qualified observer. Use of a human observer to measure stack opacity entails essentially the same considerations that would be given to use of a mechanical instrument, i.e., the calibration, accuracy, and precision of the instrument. Calibration of any instrument is achieved by comparing the test instrument's output against a known standard. Similarly, a human observer must be qualified or "calibrated" by comparing his observations of 25 white and 25 black plumes with the measurements of a calibrated smoke indicator or light transmission meter. See Appendix to 40 C.F.R. Part 60, Test Method 9 (36 FR 24895, December 23, 1971).

EPA has evaluated the accuracy and the precision of the qualified observer. Precision of an instrument refers to the ability to consistently produce essentially the same measurement or response when subjected to the same set of test conditions. A precise instrument is not necessarily accurate because interferences or improper test conditions may produce a bias that would cause the measurement to be consistently in error when compared with the "true" value of the quantity being measured. In the document entitled, Optical Properties and Visual Effects of Smoke Stack Plumes (Public Health Service Publication No. 999-AP-30.),[12/]

a description is given of tests designed to evaluate the precision and accuracy of the qualified observer (section title: Evaluation of Plumes by Trained Observers, pages 23-29). The evaluation showed that the precision of the qualified observer was reasonably good, i.e., "Group assessments showed good agreement for similar sun-plume-viewer geometrics" (p. 25), however the accuracy of the observation was greatly affected by the position of the observer with respect to the sun and plume due to light scattering effects of the plume (Figures 16, 17, and 19, and Tables 1 and 2). This light scattering interference was essentially nullified by positioning the observer with his back to the sun as is shown in Figure 16 (East: 9:30, 10:00, 10:30 a.m.) and Figure 17 (East: 9;45, 10:15, 10:45 a.m.). Figures 16 and 17 show that a qualified observer with the sun at his back was able to determine the opacity of both white and black plumes with very good agreement (accuracy) with the in-stack light transmission meter measurements.

Thus petitioners miscited test data in Table 2 of the Optical Properties report as indicating that opacity tests are unreliable. Data in this table were developed without regard to the placement of observers with respect to the sun and plume. As discussed previously, the sun must be to the observer's back to accurately determine

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opacity of a plume. The EPA test method for opacity specifically requires that "The qualified observer stands at approximately two stack heights, but not more than a quarter of a mile from the base of the stack with the sun to his back." (40 CFR Part 60 Appendix, Test Method 9).

EPA periodically conducts smoke reading courses for the purpose of qualifying candidates as smoke observers in accordance with the requirements of Test Method 9. In the smoke school, an observer is shown and assigns opacity readings to 25 different black plumes and 25 different white plumes. The readings, which are recorded on data sheets, are assigned in even 5 percent increments. In order to qualify, no single reading may be in error by more than 15 percent opacity; the average error may not exceed 7.5 percent opacity in each category.

In order to assess the accuracy and precision with which qualified observers read plumes, the results of 50 individuals were selected at random from candidates in nine smoke school courses conducted in 1972 and 1973. This provided a total of 2500 observations for analysis. These results are available in a report titled Average Observational Error Associated with Smoke Plumes at Levels of Known Opacity. [19/]

The analysis of these observations considered two parameters:

1. the average error made in observation of plumes of known opacity, and

2. the precision of individual observations of plumes of known opacity.

The results of these analyses are described below.

For each smoke plume which was observed the error or difference between the observed opacity and the actual opacity (observed opacity minus actual opacity) was recorded. For plumes of 0%, 5%, 10%, and 15% opacity, these errors were tabulated separately for the respective plume. Above this level plumes were combined into 10% opacity intervals for convenience of calculation. Thus a 5% error associated with a plume of either 20% or 25% was tabulated under the actual opacity of "20% or 25%."

Two calculations were made using the above data: the "average error," and the "average absolute error." The following example illustrates these calculations:

Data for a plume of
actual opacity = 10%
-5% error = 2
0% error = 31
+5% error = 31
+10% error = 23
+15% error = 6
93 total observations

$$\text{Average error} = \frac{2(-5\%) + 31(5\%) + 23(10\%) + 6(15\%)}{93} = +5.0\%$$

$$\text{Average absolute error} = \frac{2(5\%) + 31(5\%) + 23(10\%) + 6(15\%)}{93} = 5.2$$

The "average error" indicates the overall bias of the group with respect to a particular plume. A positive value would indicate that the average observation is greater than the actual plume, and vice-versa. As example, a -5% error and a +5% error would result in an "average error" of 0%.

The "average absolute error" indicates the average absolute accuracy attained by the observers. As example, a -5% error and a +5% error would result in an average absolute error of 5%.

The results of these calculations are shown in Table 2.

Table 2. AVERAGE OBSERVATIONAL ERROR

Actual Opacity*	Number of Observations	Average Error % Opacity	Average Absolute Error % Opacity
0	12	+3.3	3.3
5	12	+2.5	2.5
10	93	+5.0	5.2
15	96	+2.8	5.4
20 or 25	331	+2.5	5.0
30 or 35	409	+0.1	5.1
40 or 45	606	-0.1	5.5
50 or 55	393	-0.1	6.0
60 or 65	235	-0.2	6.2
70 or 75	185	-1.2	6.1
80 or 85	120	-2.4	6.0
90 or 95	96	-2.6	4.6
100	12	-5.8	5.8

*Measured with a photoelectric transmissometer located in the smoke generator stack.

A review of Table 2 shows that on the average, the smoke readings can be made with good accuracy. With two exceptions, the average accuracy is within ± 3.3 percent. At two levels of opacity, 10% and 100%, the average error was noted to be 5% and 5.8% respectively.

No test method is invariably perfectly accurate. Water vapor does not cause major problems in opacity testing. When stack emissions contain appreciable water vapor, the vapor becomes visible when the gases are cooled below the dew point and water condenses in fine droplets. Some water plumes are detached while others are visible as released from the stack.[c/] However, since ambient air is normally much drier than stack emissions containing visible water vapor, dilution causes the gases at some point to become unsaturated. At this point, condensed water evaporates and visually disappears from the plume. Trained smoke observers can discriminate between condensed water vapor and visible pollutants by determining the opacity at or after that point in the plume where the water vapor dissipates.

Under relatively warm and dry conditions, the visible water plume evaporates and becomes invisible within a short distance of the stack. In cold weather, air has much less capacity to carry water vapor, the water plume

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[c/] The phenomenon of a "detached plume" is often observed when a warm moist gas stream is released into a cooler atmosphere, e.g., when hot, wet exhaust gases from a wet process kiln are released to the atmosphere. Here the gases are clear at the point of discharge but become opaque as the wet gases mix with cooler air in the atmosphere.

from a given source is usually much more pronounced and has a longer path. Due to the character of the dust and atmospheric conditions existing at a given point in time, i.e., humidity, cloud cover, rain, snow, etc., it may not be possible in some cases to evaluate opacities of the particulate fraction with sufficient precision to warrant enforcement action. In such cases, it is necessary to make multiple observations under varying atmospheric conditions. Opacity and water vapor phenomena are shown photographically in the EPA report entitled, "A Report on Contaminated Water Vapor Plumes".[18/] The proper place to deal with such small variations is at the time of enforcement. For example, the agency would not take, and the courts would not sustain, enforcement action based upon opacity observations that do not exceed the standard by more than the average opacity error associated with the particular opacity standard. It is important to note in this connection that under §113(c)(1)(C) of the Clean Air Act criminal sanctions can only be imposed on persons who "knowingly" violate §111 standards. Also orders issued under §113(a)(4) must take into account "the seriousness of the violation and any good faith efforts to comply with applicable requirements."

Opacity standards have been tested by time, experience, and litigation. California enacted a statutory opacity requirement in 1947. California Health and Safety Code 24242, Stats. 1947, ch. 63251. In an analysis prepared for EPA by L. J. Duncan of The Mitre Corporation titled Analysis of Final State Implementation Plans - Rules and Regulations, (APTD-1334, July 1972), Table XVI (p. 51-52)[16/] shows that every State has equivalent opacity restrictions applicable to particulate emissions. These range from 0% opacity ("no visible discharges") to 40% opacity during normal operations with most restrictions being 20% opacity. Both Maryland (in two Air Quality Control Regions) and the District of Columbia have no visible discharge limitations. Various courts have upheld the validity of opacity requirements. See, e.g. State v. Fry Roofing Co., 495 F.2d 751, 4 ERC 1116 (Oregon Court of Appeals 1972); People v. Plywood Manufacturers, 291 F.2d 587 (Superior Court of Los Angeles, California, 1955).

Opacity standards are a necessary supplement to mass emission standards. Opacity standards help assure that sources and emission control systems continue to be properly maintained and operated so as to comply with mass emission standards. Particulate testing by EPA Method 5 and most other techniques requires an expenditure of $3,000 to $10,000 per test including about 300 man-hours of technical personnel.[d/] Furthermore, scheduling and preparation are required such that it is seldom possible to conduct a test with less than two weeks notice. Therefore, Method 5 particulate tests can be conducted only on an infrequent basis.

If there were no standards other than mass emission standards, operators could inadequately operate or maintain pollution control equipment at all times except during periods of performance testing. Operators are aware that two weeks or longer are necessary to schedule a typical stack test. If only small repairs were required, e.g., pump or fan repair or replacement of fabric filter bags, the operator could delay such remedial action and continue to pollute until shortly before the test is conducted. For some types of equipment such as scrubbers, the operator could reduce the energy input (the pressure drop through the system) when stack tests weren't being conducted and could release significantly more particulate than normal. Therefore, EPA has required that operators properly maintain air pollution control equipment at all times (40 CFR 60.11(d)) and meet opacity standards at all times except periods of startup, shutdown, malfunction, and as otherwise provided in the applicable standard (40 CFR 60.11(c)).

[d/] Cost applicable to retests only. Initial performance test is usually more costly because of need to erect platforms, scaffolding, or other sampling facilities.

Opacity of emissions is indicative of whether control equipment is properly maintained and operated. However, it is established as an independent enforceable standard, rather than an indicator of maintenance and operating conditions because information concerning the latter is peculiarly within the control of the plant operator. Furthermore, the time and expense required to prove that proper procedures have not been followed are so great that the provisions of 40 CFR 60.11(d) by themselves (without opacity standards) would not provide an economically feasible means of insuring on a day-to-day basis that emissions of pollutants are within allowable limits. Opacity standards require nothing more than a trained observer and can be performed with no prior notice. However, in some cases, including times when opacity standards may not be violated, a full investigation of operating and maintenance conditions will be desirable. Accordingly, EPA has requirements for both opacity limits and proper operating and maintenance procedures.

For the foregoing reasons, EPA believes that opacity standards are such an indispensible air pollution control tool for the States and Federal government, and that the range of uncertainty in applying such standards is so small that this type of standard should continue to be used by EPA as well as the States.

COSTS

The only cost issue which the Court remanded to EPA was whether the costs of a standard which precluded the use of wet process kilns and precipitators were reasonable. EPA's standard will not preclude use of wet process kilns nor of precipitators. This issue was discussed above along with the relative costs of control equipment for wet and dry process kilns.

For purposes of this remand, it is sufficient to state that EPA continues to believe that the economic costs associated with the standard are reasonable. This conclusion is based primarily on the reports: "The Financial Impact of Air Pollution Control Upon the Portland Cement Industry" by J. R. Elias and J. M. Dement[4/] and "The Cement Industry: Economic Impact of Pollution Control Costs" by the Boston Consulting Group.[13/]

ADVERSE ENVIRONMENTAL IMPACTS

The new source performance standards for Portland cement plants are not expected to result in significant adverse environmental impact. The possible areas of adverse environmental impact are: 1) increased pollution from generation of electricity required to operate precipitators, 2) water pollution from disposal of collected particulate matter. Neither of these is a serious problem.

The electric power rate required to operate a precipitator that would meet the new source standard on a typical wet process kiln would be approximately 115 kilowatts. This should be compared with the total electric power rate consumption of a typical cement plant which approximates 5300 kilowatts and with the 500,000 kilowatt output of a typical new steam generating electric power plant. The additional 115 kilowatts will thus have little incremental impact on pollution created by electric power generation generally and that created by electric power generation for Portland cement plants specifically.

The above figures were developed on the following assumptions: A typical cement plant producing 2.5 million bbl of cement annually would exhaust gases at a rate of 230,000 cfm. (Robert Elias and John Dement, "Financial Impact of Air Pollution Control Upon the Portland Cement Industry")[4/]. In order to meet the new source performance standards of 0.3 pound per ton kiln feed (1.6 ton feed per ton product), based on an emission factor of 235 pounds per ton of cement product, a precipitator would have to have a collection efficiency of approximately 99.92 percent. A study conducted by Southern Research Institute shows that precipitators recently installed on two wet process plants which have collection efficiencies of 99.92 and 99.95 percent had power rates of 440 watts per 1000 cfm and 520 watts per 1000 cfm respectively. (A manual of Electrostatic Precipitator Technology, Contract CPA 22-69-73 for NAPCA, Figure 18.10, Part II - Application Areas).[14/] At a power rate of 500 watts per 1000 cfm, a precipitator handling 230,000 cfm at a collection efficiency of 99.92 percent would require 115 kilowatts.

The total electrical consumption (excluding fuel) of a cement plant is 120 kilowatts per metric ton product. For the typical plant producing 44-45 metric tons per hour (2.1 million bbl per year), the total plant energy consumption approximates 5300 kilowatts. (Southern Research Institute, "Development Document for Effluent Limitations Guidelines and Standards of Performance: Cement Manufacturing Industry," Contract 68-01-0599).[15/]

State implementation plan requirements would require up to 81 kilowatts to be consumed in the precipitator of the typical cement kiln even if there were no applicable new source standards. State implementation plans require controls on the emission of particulate matter by cement plants ranging from 0.36 to 0.89 lb. per ton feed. ("Analysis of Final State Implementation Plans - Rules and Regulations," APTD-1334).[16/] These standards require collection efficiencies of 99.76-99.90 percent. The power rates associated with these efficiencies are between 125-350 watts per cfm. A precipitator with an approximate size of 230,000 cfm would thus require between 29 and 81 kilowatts to meet State Implementation Plan standards.

Although higher efficiency dust collectors will increase the amount of material collected, the new source performance standards will not substantially increase the land disposal problems faced by cement plants. Furthermore, it will require the collection of dust which would otherwise be vented to the atmosphere and indiscriminately deposited on land in the vicinity of the cement plant. The present practice in the cement industry is to dispose of the collected kiln dust that cannot be returned to the kiln. The waste dust is hauled or slurried to an unused part of the quarry from which the raw material came or is landfilled. Table 3 summarizes the methods employed by 80 cement plants to dispose of kiln dust.

Table 3. METHODS OF DISPOSAL OF COLLECTED KILN DUST BY CEMENT PLANTS (a)

Method	Number of Plants Reporting	Percent of 80 Plants Reporting (b)
all dust returned to kiln	27	34
surface piling (dry)	29	36
returned to quarry (dry)	11	14
leached	9	11
slurried and discarded	7	9
some sold or hauled away by contractor	8	10

(a) Source: Southern Research Institute, "Development Document for Effluent Limitations Guidelines and Standards of Performance: Cement Manufacturing Industry," Contract 68-01-0599. 15/

(b) Percentage total is greater than 100 because some plants report more than one method.

State implementation plans require controls on the emission of particulate matter by cement plants ranging from 0.36 to 0.89 lb. per ton feed. Compliance with these standards will require cement plants to dispose of substantial amounts of material. The amount of additional dust collected to meet the new source performance standards of 0.30 lb. per ton feed will not be significantly greater than that collected to meet the state implementation plan standards.

For similar reasons, the increased amount of material collected by higher efficiency dust collectors will not substantially increase the risk of water pollution. Present land disposal methods could permit dust with a high alkaline content to cause potential water pollution problems from rainfall runoff or by percolation into streams and rivers. If alkalai dust were not controlled but instead were released to the atmosphere, it would also find its way into streams and rivers. However, containment and treatment of runoff from kiln-dust piles will eliminate the danger of water pollution resulting from alkalai cement dust. The Southern Research Institute study previously cited (EPA Contract 68-01-0599)[15/] indicates that technology exists to treat the contaminated water resulting from leaching and describes that technology.

In any event, the increase in the collection of particulate due to new source performance standards as compared to the collection of particulates resulting from the application of state implementation plan requirements will be insignificant.

SUMMARY

EPA thus concludes that the standards are achievable and have been achieved by both wet and dry process kilns, that the economic costs are reasonable and that the adverse environmental impact is minimal. EPA further concludes that the opacity standard is a valid and necessary standard which meets the requirements of §111 of the Clean Air Act. Therefore, EPA, after reconsidering the standards pursuant to the remand of the U. S. Court of Appeals for the District of Columbia, has concluded that the standards should not be changed.

APPENDIX I

EPA RESPONSES TO SPECIFIC ISSUES RAISED BY THE COURT

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APPENDIX I

This appendix contains responses to specific issues raised by the U.S. Court of Appeals for the District of Columbia in the Portland Cement case. References are to the Slip Opinion.

Issue 1

On page 21, the Court asks EPA to respond to petitioner's comments concerning possible adverse environmental impact of the standards.

Response

These impacts are discussed in the text above.

Issue 2

On page 23 and 24 and again on page 41, the Court asks EPA to consider the justification for and economic impact of standards that would terminate the use of wet process kilns and precipitator control of both wet and dry process emissions.

Response

EPA's standards do not preclude the use of either wet process kilns or precipitators. Test results show both have met the standards. This is discussed in the text above, along with economic considerations.

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Issue 3

In footnote 55, the Court said:

> "If the same technology is now available and in use for incinerators, steam power plants and cement plants, the Administrator on remand may wish to offer some further explanation of the difference in standards set simultaneously for the three industries."

Response

At the time the cement, incinerator and steam generator standards were promulgated, EPA had data showing that baghouses would enable both wet and dry process Portland cement kilns to achieve concentration levels of .03 grains per dry standard cubic foot (gr/dscf) or less. EPA judged but had not confirmed that a precipitator could achieve the same levels. EPA also suspected but had inadequate data to confirm that incinerators and steam generators could use baghouses to achieve concentration levels approximating those achieved by cement kiln baghouses.

Because different types of sources emit gases of different composition at different velocities, it cannot be assumed that a device that removes particulates will be equally effective in removing every type of particulate from every type of source. Furthermore, different types of sources may emit substances which will interfere with the operation of the control equipment.

Thus EPA based its incinerator, steam generator and cement standards primarily on applying baghouses to cement plants and assumed less efficient precipitators would be used for incinerators and steam generators, although EPA had indications that baghouses could be applied to incinerators and steam generators and that precipitators could achieve emission concentrations similar to those of baghouses.

As noted in the text above, precipitators on cement kilns do achieve the standards. As data is gathered showing precipitators, baghouses, or other dust collectors on incinerators and steam generators also can achieve similar concentration levels, the standards for these sources will be revised. Any data the cement industry has on the emission levels which can be achieved by incinerators and steam generators should be submitted to EPA to facilitate the review of the standards for these two source classes.

ISSUE 4

On page 37 the Court directs EPA to consider contentions presented in briefs to this Court, though not previously raised, unless EPA explains why they are not material.

RESPONSE

The above text and these responses to questions raised by the Court effectively respond to the points raised by petitioners.

ISSUE 5

In footnote 73 the Court says it is uncertain whether the test was referred to in the Background Document as not available at the time this document was published was of one of the two kilns tested at the Dragon Plant or was located at still another plant.

RESPONSE

The missing test was that of the Giant Portland Cement plant in Harleyville, South Carolina, a wet process plant with a baghouse.

ISSUE 6

On page 40, the Court questions whether a single test is an adequate basis for inferring that all new cement plants would be able to meet the proposed standards.

RESPONSE

At the time the standard was promulgated, EPA had tested two plants which met the standard (The Dragon and Oregon plants). Each test consisted of three repititions of two hour sampling periods or six total hours of testing. EPA has since obtained test results from two other plants which show emissions well below the standard: The Lehigh Portland Cement Co. and Marquette Cement Manufacturing Co. tests referenced in the text above.

The Court in raising this issue referred to a letter from Mr. Kreichelt which was critical of EPA's basing the standard on tests which showed the standard was met at only one plant. As three additional plants have since been tested which meet the standard, Mr. Kreichelt's criticism is no longer applicable. However, even if it were, the following considerations should be taken into account in evaluating his criticism. First it was based on the assumption, correct at that time, that EPA's test method would include particulates collected in the impinger portion of the sampling train. Upon this assumption, the one test result (Dragon Cement) referred to by Mr. Kreichelt showing the standard could be met would show an average of .184 pounds per ton compared with the standard of .3 pounds per ton. However, the deletion in the promulgated standard of the requirement that impinger catch must be included means that the Dragon plant in fact tested at .07 pounds per ton or less than one-fourth of the standard.

Second, as noted, test results have since become available which show three more plants, including a wet process plant, have met the standard.

Third, even if EPA did not have these additional test results, the Agency is not constrained to accept Mr. Kreichelt's definition of what is "achievable." The greater the number of tests required to prove a standard can be met before the standard can be promulgated, the greater the likelihood the new source performance standards would reflect only the technology and maintenance requirements which existing plants have chosen to apply. However, EPA was testing to determine the best levels of control being achieved at existing plants. Engineering judgment was then applied by EPA to determine whether new plants could be constructed to perform at control efficiencies equal to or better than that observed at the tested existing plants. EPA was not attempting to determine the statistical average performance of existing plants.

ISSUE 7

On page 41, the Court questions whether validity of standard is affected by the different testing method required by EPA in the promulgated standards and that used by EPA in its tests in developing the standards. The Court first refers to the elimination of the requirement in the promulgated standard that the impinger catch of the sampling train be included in determining the particulate emissions.

RESPONSE

In EPA's proposed standards the particulate sampling method required that both the front half (probe, cyclone and filter) and back half (impinger) catches of the sampling train be measured. When EPA tested the Dragon and Oregon plants, it calculated the pounds of particulate per ton of feed by adding the amounts collected in both the front and back half of the sampling train. However, EPA separately measured both front and back half catches. (See Summaries of Test Data for Standards of Performance for New Stationary Sources, August 1971.)[17/] Thus, the change in test methods in no way invalidated EPA's test results. It only rendered some of the data valueless. Based only on the probe,cyclone and filter catch data, the Dragon Cement plant emitted an average of 0.07 pounds per ton during the test of that plant (See Summaries of Test Data and Emission Testing Report, ETB Test Number 71-MM-05)[5/] and the Oregon plant emitted an average of 0.28 pounds per ton (See Emission Testing Report, ETB Test Number 71-MM-15).[9/]

ISSUE 8

On page 42, the Court asks the Administrator to explain why compliance with the standard is based on a two-hour test while the data base was developed on 30-minute tests?

RESPONSE

There were four ports to be sampled at Dragon Cement; during each of the three tests each port was tested for 30 minutes for a total sampling time of 2 hours, the time required for compliance test. Thus, there are inevitable time periods during which no sampling will be done as it takes time to correctly position and adjust the sampler at each traverse point. The Sources subject to this standard will also have such gaps in their own tests, which gaps will not invalidate their tests.

The general provisions of 40 CFR 60 are being revised to clarify the fact that a run or repetition may be either continuous or intermittent, consistent with good engineering practice. This revision does not alter the test method; it only makes clear the fact that the normal practice of interrupting runs for such purposes as moving sampling equipment or sampling cyclic processes is, in fact, expected and is an accepted procedure which is within the scope of the test method.

ISSUE 9

On page 42, the Court raises the question on the basis of a handwritten note made by the EPA contractor, as to whether the tested plant was operating at maximum performance during testing. The contractor had noted, "Baghouse is undersize and production is held back due to this." Compliance tests under the regulation require, however, that "All performance tests shall be conducted while the affected facility is operating at or above the maximum production rate. . . ."

RESPONSE

The handwritten note of the EPA contractor refers to a presurvey note of an EPA engineer. That note referred to the potential production capacity of the plant as reported by plant personnel and did not indicate that the Dragon Cement kiln was being operated at an abnormally low production rate.

A cement plant's production rate is related to many variables in the system. A few of the variables that could influence or limit the production rate are: the capacity of the grinders, the size of the kiln, the size of the fans or pumps in the system or the size of control equipment installed to control particulate emissions from the kiln. In addition, variables such as kiln temperature, pressure, Btu content of fuel, excess air for combustion and moisture content of the feed could all directly or indirectly affect the production rate of the cement plant.

The baghouse installed at Dragon Cement was sized for the production rate desired by the company taking into account the other variables in the system. During the test period, the plant was operated at its normal maximum production rate.

ISSUE 10

On page 42 and 43, the Court restated petitioner's contention that EPA erred in the Dragon test in (a) not using observed measured values, (b) substituting lower reading from another test run for a reading based on contamination of the sampler by solids, and (c) pouring liquid obtained from one run into the beaker used to hold liquid from another run. The Court went on to say "However, deviations from prescribed measurement techniques are not necessarily significant as to testing results, and if petitioners press this point on remand they must establish that such test deviations bear significant consequences." Nevertheless, in the interest of providing a complete response to the Court's remand EPA will respond to this issue.

RESPONSE

Petitioner's comments were based on comments made by EPA on page 7 of the Dragon Test Report, ETB Test No. 71-MM-05.5/ EPA has to test existing plants as they are. The Dragon plant had allowed solids to build up in the duct downstream of the baghouse. These solids, which EPA was unaware of until after Test Run 1, contaminated the probe and cyclone and also reduced the cross section of the duct. In order to correct for these solids, EPA had to compute the cross section of the duct through which air could pass.

The catch of the front half of the sampling train is measured by adding together the probe and cyclone catch and the filter catch. The probe and cyclone capture large particles and the filter catches smaller particles. It was observed that the probe and cyclone in Test Run 1 captured 98.1 mg of particulates while the probe and cyclone catch in Run 2 was 15.9 mg and in Run 3 was 18.0 mg. It was also observed that at one sampling point in the duct the gas velocity was zero. This led to an inspection of the duct which showed that solids were in fact deposited on the bottom. The probe and cyclone had obviously collected some of these particles. Therefore, the catch of the probe and cyclone was assumed to be 17.0 mg, the average of Runs 2 and 3. The actual filter catch in Run 1, 38.6 mg, was used. Thus a part of the Run 1 results were calculated rather than measured. However, the possible error introduced in this one portion of one Test Run at the Dragon plant was so small that in the opinion of EPA it does not substantively prejudice the results of the Dragon test and certainly not the standard, which was based on other tests in addition to the Dragon tests.

The mistake in pouring liquid obtained in one run in the wrong beaker is now irrelevant since the liquid was impinger water. The promulgated standard deleted the requirement that impinger catch be added in ascertaining compliance.

ISSUE 11

On pages 43-44, the Court directs EPA to respond to criticisms expressed by Mr. Striker to the effect that EPA underestimated the stack gas flow rate, and thus the amount of particulates emitted, by a factor of two.

RESPONSE

Before responding to specific allegations of error made by Mr. Striker, it is important to note that even if Mr. Striker were correct in his allegations, and EPA believes that he is not, the tests would still show that the Dragon Cement Plant met the EPA promulgated new source performance standard. Mr. Striker concluded that the "correct emission of particulate matter is in the neighborhood of .404 pounds per ton of kiln feed." But this figure was reached by using 0.2 lbs/ton based on the entire train for the first, and maximum, of three tests. After changing to a front-half catch only, (the terms of the promulgated new source performance standard), the result from this test was 0.11 lbs/ton and even if the error that Mr. Striker claims had been possible and had occurred, test results from this maximum test would be 0.22 lbs/ton and average test results would change from .07 lbs/ton to .14 lbs/ton, well below the standard of 0.3 lbs/ton.

It is this average of three tests that is to be used for compliance with the new source performance standard. This plant would still be well below new source performance standards of .30 lbs/ton.

In any event, EPA has thoroughly considered Mr. Striker's specific allegations of error and disagree with him. Mr. Striker's allegations are well summarized by the Court as follows:

> Finally, engineer Striker claims significant errors of measurement were made in determining the measurement of the cubic feet of stack gas per minute, and a resulting understatement of the true volume of calcining carbon dioxide included in total stack gas. He states that commonly "35% (plus or minus 1%) of raw feed is converted into carbon dioxide in the burning process." He then notes that an accurate measure of raw feed is the volume of calcining carbon dioxide appearing in stack gas, which in turn depends on an accurate measure of the volume of stack gas. His own calculations, based on EPA data showing a stack flow rate of 51,187 cubic feet per minute of dry gas, indicate that there were 2,153 cubic feet per hour of stack gas in the test attributable to calcining carbon dioxide coming from the raw feed and that "as a matter of basic chemistry" 2153 cubic feet of calcining carbon dioxide "comes only from 22.11 tons of raw feed." This was at variance from the kiln rate of 44.03 tons of raw feed per hour reported in the test. He concludes that the error lay not in the measurement of the raw feed, but in the test data reported on the stack gas volume -- flow rate of 51,187 -- which in his judgment requires more sophisticated equipment for recording than does the raw feed which is easily measureable. Having corrected the stack gas figure, he states his opinion that the EPA assumption of emissions satisfying its ultimate 0.30 standard was in error. He concluded:
>
> > It is my personal opinion that the particulate matter emissions of .202 pounds in test 1 per ton of kiln feed reported . . . is grossly erroneous and that the correct emission of particulate matter is in the neighborhood of .404 pounds per ton of kiln feed.

> We are not competent to decide if Mr. Striker's methodology and conclusions are correct. We can note, however, that he claims that as a matter of "basic chemistry" two test values, for feed and gas volume, cannot co-exist. This is certainly the type of criticism EPA should be required to discuss on remand.

The possible error in measurement of dry stack gas volume has been gone over repeatedly by EPA engineers and Mr. Striker. Basically the situation is this: Mr. Striker claims that the CO_2 does not balance in the system, i.e., that the calculated CO_2 from combustion plus CO_2 driven off from the calcium carbonate is not equal to the CO_2 calculated from Orsat (gas composition) readings and stack gas flow measurement. Mr. Striker's CO_2 calculations on the CO_2 balance appear to be essentially correct. Mr. Striker's error lies in his assumption of the cause of this CO_2 discrepancy. There is no conceivable source of error in measurement of the stack gas flow rate that could even approach 100%. Moreover the gas flow rate was measured consistently during twelve traverses at a total of 180 points. Nowhere does Mr. Striker say where such an error could occur.

A flow rate as suggested by Mr. Striker was impossible because of the plant design. Neither the fan nor the baghouse could have possibly handled such a volume. This has been confirmed with the plant management. Further evidence of the correctness of EPA measurements (and the incorrectness of Mr. Striker's assertions) is contained in later test resul-s from the Dragon Cement plant cited by Edward Klein of Martin-Marietta (owners of Dragon Cement Co.). These results show flow rates very close to those measured by EPA at full production (as in EPA tests)[20/]. The summary of these test results supplied by Mr. Klein is available from EPA. Thus Mr. Striker's allegations would violate the basic laws of nature had they been correct. Mr. Striker assumes that everything measured was correct except for a 100% error in stack gas volume. Under that assumption our number when expressed as pounds per ton of feed should have been twice that stated. As shown above, this could not be the case.

There are two other possible sources of this CO_2 error: feed rate and Orsat (gas composition) analyses. Mr. Striker agrees that kiln feed rate is not in error. The plant was operating steadily at full production rate. A check with plant personnel shows our feed rate and their records to be in agreement. It should be pointed out that Orsat analysis for oxygen, carbon dioxide, and other combustion gases were only incidential to particulate testing. They in no way affect results. Kiln feed is the chief variable of cement production and careful control is maintained. Any substantial variation would have been noticed by the plant.

Thus, the only possibility is that the error was in the Orsat analysis (% of each gas in effluent). Calculations performed by EPA experts on this indicate that the CO_2 absorbing solution in the Orsat was exhausted and CO_2 in the stack gases was not measured as CO_2 but rather as oxygen. Checks with EPA emission testing engineers who supervised the test confirm that this was the source of discrepancy in the CO_2 balances.

In order to determine the pounds of particulate per ton of feed it is necessary to sample the amount of particulates per unit of gas emitted and then multiply this figure by the total amount of gas emitted during the period a measured amount of feed is consumed. This is what EPA did in calculating the emission rates from the plants tested. If, Mr. Striker's allegations were correct, the emission rate would indeed need to be changed. The error in the Orsat analysis explains the apparent violation of the laws of "basic chemistry" but does not necessitate any change in the test results reported.

ISSUE 12

On page 44 and 45 and in footnote 90, the Court suggests that if their study of the matter is correct, the Oregon wet process kiln test results to be compared with the standard, i.e. front half catch only, are .247, .309 and .261 lbs/ton rather than .535, .361 and .291 lbs/ton.

RESPONSE

The court is correct. The average test results for the Oregon test which should be compared with the standard is .28 lbs/ton.

ISSUE 13

On pages 45 to 47, the Court expresses concern that problems at the Oregon plant caused interruptions in the sampling. The Court suggests that a provision allowing for malfunctions could be taken into account in considering this issue on remand.

RESPONSE

The testing of the Oregon plant is described in the test above. During the testing period at Oregon Portland Cement plant, a test was begun on 10/7/71 and discontinued due to kiln shutdown. The test was resumed and completed on 10/8/71. Two additional tests were run on 10/8/71 with only short interruptions to change ports as required by the test method. On October 5 and 6, 1971, two earlier attempts were made at measurement of emissions but conditions prevented meaningful measurements. The important things to note are that process operation was extremely upset during these attempts and did not represent normal operating conditions and that the manner in which the early attempts at testing were performed was an attempt to make a test at normal operating conditions. The second and third tests recorded were at normal operating conditions (not artificially ideal conditions) to be expected during normal cement plant operation. No stop-start testing, as described in the petitioners' quote, was used (except as noted in the response to Issue 8). The first test recorded had only one interruption (other than port changes) due to the kiln shutting down. The circumstances described above are in ETB Test Report Number 71-MM-15,[9/] (pages 16 and 47), the same report quoted by petitioner.

The fact that the Oregon plant was not being properly operated or maintained does not limit EPA to standards based on tests conducted during periods of malfunction. EPA attempts to determine the best levels that a plant can achieve. In any event, the testing at the Oregon Portland Cement plant was consistent with the manner of conducting performance tests under the proposed revision to §60.8(c) of Title 40, Code of Federal Regulations. 38 Fed. Reg. 10820-21 (May 2, 1973). That section provides that compliance tests shall be based upon representative performance, which shall not include periods of startup, shutdown, and upset. EPA has promulgated regulations which make it clear that EPA's mass emission limits apply only during performance tests rather than at all times. (38 Fed. Reg. 28565, October 15, 1973).

ISSUE 14

On page 48, the Court directs EPA to state with specificity what literature is relied on to support the standard.

RESPONSE

This is discussed in the text above. As indicated in the text, a principal literature source was a government publication, resulting from a study conducted in cooperation with representative companies manufacturing portland cement entitled, "Atmospheric Emissions from the Manufacture of Portland Cement". This principal literature source provided basic information regarding cement plants, including process details, process equipment, types of control equipment utilized, and documentation that baghouses could be used for the control of particulates from both wet and dry process kilns, i.e. that baghouse control is "adequately demonstrated." In addition, the names of cement companies - location and size of cement plants were listed and this information was utilized by locating the best controlled plants to be considered for inspection and possible source testing in conjunction with the development of new source performance standards. Source test data included in the report were not relied on by EPA to show that the standard was being met.

ISSUE 15

In footnote 95, the Court states that if vendor representations are to be relied on, more might be required than mere comments.

RESPONSE

The relevance of vendor statements is discussed in the text above. The tests EPA conducted were sufficiently supportive of EPA's standards that vendor representations, although relevant to confirm the standard can be met, are not of such crucial importance that the time and effort required to go beyond their professional representations is warranted.

ISSUE 16

On pages 49-52, the Court directs EPA to reconsider the opacity standard.

RESPONSE

This is discussed in the text above.

REFERENCES

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2. Control Techniques for Particulate Air Pollutants, U.S. DHEW, PHS, CPEHS, National Air Pollution Control Administration, Washington, D. C., NAPCA Publication No. AP-51, 1969.

3. Establishment of National Emission Standards for Stationary Sources, Volume VI, Portland Cement Manufacturing Plants, Contract No. CPA-70-164, Task Order No. 2, Prepared for the National Air Pollution Control Administration, Durham, N. C., by Research Triangle Institute and PEDCo Environmental Specialists, Incorporated, 1970.

4. The Financial Impact of Air Pollution Control Upon the Portland Cement Industry, Internal document, Environmental Protection Agency, Raleigh, North Carolina, 1971.

5. Emission Testing Report, Environmental Protection Agency, ETB Test Number 71-MM-05, Dragon Cement Company, Northampton, Pennsylvania.

6. Emission Testing Report, Environmental Protection Agency, ETB Test Number 71-MI-03, Ideal Cement Company, Seattle, Washington.

7. Emission Testing Report, Environmental Protection Agency, ETB Test Number 71-MM-01, Maule Industries, Hialeah, Florida.

8. Emission Testing Report, Environmental Protection Agency, ETB Test Number 71-MM-07, Giant Portland Cement Company, Harleyville, South Carolina.

9. Emission Testing Report, Environmental Protection Agency, ETB Test Number 71-MM-15, Oregon Portland Cement Company, Lake Oswego, Oregon.

10. Emission Testing Report, Lehigh Portland Cement Company, Union Bridge, Maryland, dry process, electrical precipitator, Union Bridge No. 4 kiln, Tested by Resources Research, Inc., 1972.

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11. Emission Testing Report, Marquette Cement Manufacturing Company, Hagerstown, Maryland, dry process, electrical precipitator, Tested by Marquette Cement Manufacturing Company, 1972.

12. Optical Properties and Visual Effects of Smoke-Stack Plumes, U. S. DHEW, PHS, Bureau of Disease Prevention and Environmental Control, Cincinnati, Ohio, PHS Publication No. 999-AP-30, 1967.

13. The Cement Industry: Economic Impact of Pollution Control Costs, Volume I, Contract No. EQC-204, Prepared for the Council on Environmental Quality and the Environmental Protection Agency, Washington, D. C., by the Boston Consulting Group, 1971.

14. A Manual of Electrostatic Precipitator Technology, Part II--Application Areas, Contract No. CPA 22-69-73, Parepared for the National Air Pollution Control Administration, Cincinnati, Ohio, by Southern Research Institute, pp. 609-640, 1970.

15. Development Document for Effluent Limitations Guidelines and Standards of Performance, Cement Manufacturing Industry, Contract No. 68-01-0599, Draft report prepared for the U. S. Environmental Protection Agency, Washington, D. C., by Southern Research Institute, 1973.

16. Analysis of Final State Implementation Plans--Rules and Regulations, Contract No. 68-02-0248, Prepared for the U. S. Environmental Protection Agency, Research Triangle Park, N. C. by the Mitre Corporation, Office of Air Programs, Publication No. APTD-1334, 1972.

17. Standards of Performance for New Stationary Sources, Summaries of Test Data, Internal document, U. S. Environmental Protection Agency, Durham, N. C., 1971.

18. A report on Contaminated Water Vapor Plumes, Internal document, U. S. Environmental Protection Agency, Durham, N. C., 1973.

19. Average Observational Error Associated With Smoke Plumes At Levels Of Known Opacity, Internal Document, U. S. Environmental Protection Agency, Durham, N.C. 1973.

20. Letter From Martin Marietta Cement Company (Formerly Dragon Cement Company), Confirming Gas Flow Rates As Measured By EPA During Test No. 71-MM-05, Dated August 24, 1972.

APPENDIX II

EPA RESPONSE TO PETITIONERS' COMMENTS REGARDING EPA RESPONSE TO REMAND

APPENDIX II

Portland Cement Association Comments

Adverse Environmental Impact

Portland Cement Association (PCA) objected to the draft response to the issue of the environmental impact associated with the electricity required to operate the control technology. In particular, PCA objected that the Agency should not have compared the electricity required to operate the control technology needed to meet EPA standards with the electricity required to meet State pollution control standards. PCA believed that State regulations "do not furnish a valid basis to excuse EPA from its statutory duty because most of those regulations, were in effect, mandated by EPA itself." EPA did not mandate specific State particulate emission limitations.

Prior to the date that new source performance standards and implementation plans were proposed, many progressive State and local air pollution control agencies had promulgated rules and regulations that were as strict or stricter than those required by EPA to assure that national ambient air quality standards would be met. For example, the State of Maryland had promulgated regulations[1/] that allowed no visible emissions and mass emission standards that are as stringent as EPA new source performance standards.

After the Clean Air Act was signed into law, EPA was required to review State implementation plans to determine whether they would achieve and maintain national ambient air quality standards, including standards

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for particulates. In some cases, EPA promulgated emission limits where the State plans did not adequately achieve or maintain the national ambient standards. However, the State was free to determine which emission sources should be reduced to meet the ambient standards or to achieve more stringent ambient levels. It is, therefore, incorrect that EPA "mandated" specific State particulate emission limitations.

Furthermore, EPA did not limit its consideration of the adverse environmental impact of the electricity required to operate the control equipment to a comparison of the impact of EPA's standards with the impact of State standards. EPA in its remand response compared the approximately 115 kilowatts required to operate a precipitator that would meet the new source performance standards with the total electric power rate consumption of a typical cement plant which approximates 5,300 kilowatts and with the 500,000 kilowatt output of a typical new steam generating electric power plant. EPA believes that this comparison alone indicates that a detailed discussion of the incremental and environmental impact associated with the additional 115 kilowatts required to meet the new source performance standards is unwarranted. Furthermore, EPA would note that the 115 kilowatt increment is based upon the assumption that emissions would otherwise be totally uncontrolled. It is nearly inconceivable that States and/or local governments would permit Portland cement plants to be operated without any particulate control whatsoever but for EPA's requirement of such control.

PCA also objects that EPA's consideration of the environmental impact of water pollution from the run-off from kiln dust piles has been inadequately considered. First, it should be noted that water pollution resulting from particulate matter is not a question of whether water pollution occurs, but where it occurs. Uncontrolled emissions deposit the particulates throughout the countryside where it then washes into water supplies. On the other hand, removing particulates from exhaust gases enables the source to collect the particulate matter and thus control water run-off of the particulate matter should it occur.

Second, much of the particulate matter collected by emission control devices can be used by Portland cement plants. Thus, the total amount of particulates disposed of will be less if collected by emission control devices than if vented uncontrolled into the atmosphere.

The technology for control of water run-off from dust piles is similar to that required for coal pile drainage, yard drains, and run-off from construction. These streams must be wholly or partially detained during storm events in order to minimize overall treatment costs. Diking, ditching, and holding technology can practically be utilized in conjunction with facilities for sedimentation or filtration for solids removal and for pH control.[8/] EPA does not believe that water run-off from piles of particulate emissions from Portland cement plants is a major problem. To the extent there is a problem, it is the judgment of the Administrator that the problem of water run off from collected piles of particulate matter is less than the problem of uncontrolled releases of particulate matter into the atmosphere.

Cost-Benefit Analysis

PCA argues that EPA should do a cost benefit analysis. Such an analysis has not been made because reasonable means for doing so do not yet exist, in the opinion of EPA. An emission limitation on a specific type of emission source will have different effects on ambient levels in different places. Ambient levels are affected not only by emission levels of specific sources but also the placement of such sources relative to other sources and to meteorological conditions around each of such sources. Furthermore, sources vary in their geographical relationships to populations, wildlife, vegetation and other factors which would be impacted by the emission source. Thus relating the cost of control to the benefits of the control at least at this time is a practical impossibility.

We believe that Congress intended §111 to be used to establish emission limitations which are the lowest that can be achieved by that industry. Where the cost of meeting such standards would be so great that the industry could not bear the costs and survive, such standards could not be implemented by the industry regardless of technological feasibility. There are also cases where a reduction in emissions that would be achieved by a particular control technique would be so grossly disproportionate to the cost of the control technique that it would not be required. However, these determinations are necessarily judgmental and are left specifically to the Administrator in §111. EPA does not believe that cost benefit analysis can be established for standards under §111 nor does it believe that Congress intended that standards be established or justified on the basis of such an analysis.

Although EPA has not conducted a cost benefit analysis for these standards, we have considered PCA's criticisms of the standards based on cost benefit analysis. PCA relies heavily on a conceptual chart published in an HEW publication: Control Techniques for Particulate Air Pollutants, Pub. No. AP-51. This chart shows a smooth curve relating "Capital Costs" (although no units are shown on the chart) to efficiency of the control techniques. The chart shows the curve rising asymptotically as efficiency approaches 100 percent. However, this chart does not represent

the realities of control of particulate emissions in the Portland cement industry. The primary method of control relied on by EPA at the time the standards were developed was control by baghouses. Baghouses when properly designed, installed, and maintained operate at nearly the same collection efficiency, thus the relationship between cost and efficiency is somewhat inelastic. It is well established that properly designed and maintained baghouses can limit emissions to .03 grains per actual cubic foot (ACF) of emission air and gases. EPA tests confirmed that baghouses already installed on Portland cement plants were capable of achieving .03 gr/acf if properly maintained and operated. In fact, EPA believes and recent tests confirm that baghouses can achieve higher removal efficiencies. However, at some point of control where emission levels are less than .03 gr/acf the removal efficiencies will not increase to any great extent regardless of the cost of the equipment. It is only coincidential that the standard for Portland cement plants results in costs that fall below the level where costs rise sharply compared to increased removal efficiency. This type of cost-effectiveness analysis was neither the basis for setting the Portland cement standard nor any other new source performance standard. In general, a standard will not be established at a level at which the cost of compliance would result in the inability of new plants to compete with established firms in the industry. This type of analysis is not based upon cost effectiveness but rather upon the economic structure of the industry as a whole.

PCA commented that if cost benefit comparisons were made between the standards for Portland cement plants on the one hand and coal-fired power plants and incinerators on the other, they would indicate that the Portland cement standards should be loosened and the others should be tightened to achieve a cost benefit equality. The particulate standards for coal-fired power plants and incinerators were based on the use of precipitators. Although there were indications at the time the standards were promulgated that precipitators could be used on Portland cement plants and baghouses could be used on coal-fired power plants and incinerators, EPA based its standards on the methods which had been established as applicable to the source subject to the standard. Furthermore, EPA based its particulate standards for power plants and incinerators on emission levels being achieved at existing plants. Because the removal efficiencies being achieved by properly maintained and operated baghouses on Portland cement plants were superior to those being achieved by power plants and incinerators, the effective emission concentration limits were more restrictive for Portland cement plants.

It now appears that precipitator technology may achieve the same levels of control, i.e., below .03 gr/acf, required of the Portland cement industry and that baghouses can be applied to the other two industries. EPA will consider whether the particulate standards for the other two industries should be tightened. However, EPA does not believe that inequalities between the effective emission concentration limits between these three types of sources should be eliminated by loosening the standards applicable to Portland cement plants as urged by PCA to permit such plants to emit an additional "10,000 tons per year" (PCA's figure) of particulate matter to the atmosphere.

Cost Estimate

PCA commented that EPA underestimated the cost of achieving the standards. PCA particularly objected that EPA did not use cost figures supplied by the industry. EPA does not agree with the industry's cost estimates. The costs presented by PCA did not speak specifically to the costs resulting from the standard of performance for new cement plants. The estimates reflect the total costs necessary to meet State emission standards and the Federal standard. It is not possible to separate the two cost estimates in the submittal by PCA. In addition, PCA spoke only to the investment cost for pollution control and did not present any costs for operating and maintaining the equipment. As a result, the cost estimates submitted by PCA were of no value in estimating the costs resulting from the standard of performance.

A study of the economic impact of pollution control costs upon the cement industry was performed by the Boston Consulting Group and published in 1971.[2/] One of the conclusions reached was as follows:

> "The combined effects of plant size advantage, required pollution control expenditures on existing plants, and labor cost pressure will motivate a rate of plant construction in excess of the rate of demand growth, which itself will exceed that of the past decade. The consequence will be a substantial increase in plant construction, virtually all of which will be in plants with kiln sizes of 2.5 million barrels and above."

Although the costs used in this study were supplied by EPA, the report goes on to state:

> "If the industry estimates of total and anticipated pollution control costs were used, instead of the EPA figures, the foregoing conclusions would not be changed, but would be intensified."

In summary, the Boston Consulting Group study forecasts an increase in new construction, not a decrease.

PCA further argues that inflation will change the cost figures. It is true that inflation will change the absolute magnitude of the cost figures. It is also true, however, that cement prices have risen at a rate at least equal to the overall rate of inflation. The existence of inflation is not a factor that invalidates the cost impact originally presented since it tends to affect all items, revenues as well as costs, and leaves the relative impact unchanged.

PCA also criticizes the Boston Consulting Group study on the basis that it considered a model plant rather than "widely ranging variations in raw material availability fuel costs and availability, and regional marketing considerations." PCA argues that EPA should show that capital will be obtainable to finance pollution control equipment.

Raising capital does not appear to be much of a problem for cement plants, even for pollution control equipment. The following comments are taken from the January 1974 volume of Pit and Quarry, an edition that highlighted past and future developments in the cement industry: "No new plants went into operation in 1973. There were, however, eight major expansions involving new kilns, at least three of which might be considered as a new plant alongside an older one. In all, seven new kilns and 17 grinding mills are known to have been installed during the year." Obviously, capital was available for these expansions.

Specifically with regard to pollution control equipment, the Pit and Quarry article mentioned above states that "1973 was another record year for the installation of dust collectors. At least 34 electrostatic precipitators, 17 baghouses, and 2 gravel bed filters are known to have been installed, most of them on kilns, but some also on coolers. These figures are far above those in 1972 and 1971, which were record installation years. The rate of installation of smaller collection units was also undoubtedly ahead of any previous year." In light of the above, we find it difficult to believe that capital availability is a problem in the cement industry.

EPA believes it has adequately considered cost even though it has not conducted an analysis of the costs for pollution control for each and every projected new plant and has not shown where and how the capital for pollution control equipment is to be raised by such plants. The cost of pollution control is one of several factors that might affect a company's decision to locate a plant at a given site. EPA does not believe that §111 demands the finely tuned cost analysis demanded by PCA. Furthermore, the agency believes that a plant by plant analysis is impractical and that the model plant representing average facilities is the best approach.

Demonstration of Achievability

PCA criticizes the testing procedures which EPA used to determine that the standard can be achieved. PCA admits the standards can be achieved. They state that:

> "Petitioner does not contend that the .03 gr/scf Standard cannot be achieved. Indeed, as stated in Section II above, it is believed that efficiencies in excess of 99.9 percent can be achieved with existing technology and available equipment applied to many traditional stationary sources of particulate pollutants, including cement plants." (PCA Comments to EPA draft response, p. 13, note 7.)

This should be dispositive of this issue. However, EPA has considered each specific criticism of PCA on this issue and for purposes of developing a complete response, will address each issue here.

Apparently the bases of PCA's criticisms are that some tests showed the standards were not being met, that each test that showed the standards could be met had some defect or was not adequately verified by EPA and in particular that EPA discontinued testing one plant (the Oregon plant) that was poorly maintained until broken bags were tied off.

PCA apparently construes §111 as requiring EPA to set a standard of performance for new sources that is the lowest emission level achieved at any existing plant regardless of how poorly the pollution control equipment is maintained or operated. The purpose of §111 is clearly to require new sources to use the best pollution control equipment which new sources can obtain. In order to determine what emission levels new sources can obtain, EPA is required to look at the best equipment used by existing plants, not the average and certainly not the worst. Furthermore, §111 standards are not required to permit new sources to use inadequate maintenance simply because some existing plants are inadequately maintained.

Turning now to specific criticisms by PCA of EPA's testing, PCA argues that at the Dragon cement plant test the admitted presence of settled dust in the duct at the test point raises further doubts as to the accuracy of the results obtained. The Dragon cement plant test was conducted by expert source test personnel. The settled dust in the duct was recognized. The layer of dust reduced the cross-sectional area and this was considered in calculations for the total volumetric flow rate.

PCA objects that the location of the test point in the Dragon cement plant did not comply with the EPA test procedures set forth in Federal Register Vol. 36, No. 247, Section 60.85.

The test conducted at Dragon Cement plant was conducted before test procedures were detailed in the Federal Register for new plants. It must further be realized that testing had to be conducted at existing plants to show what levels of emission control were achievable by new plants. EPA could not construct well-controlled plants with proper duct configurations solely for standard-setting purposes. It is conceded that ductwork at the plant was not ideal; however, in order to compensate for this, sampling was conducted at a larger number of traverse points than would normally be used at a test location with a suitable ductwork configuration and a precision low-range inclined manometer was used for the velocity measurements. This type of manometer permitted a higher standard of precision by expanding the scale to improve readibility and sensitivity of the velocity head measurements. In addition, three separate test runs were conducted, each of which indicated compliance with the standard. If results of each test run had varied widely, then there could have been serious doubts concerning the test results. This was not the case.

PCA objects that the Orsat analysis which EPA admits was inaccurate affects the results of the source test conducted at the Dragon Cement plant. While petitioner is technically correct, the inaccurate Orsat analysis introduced only a small error due to the slightly different density of the gases. It appears that the actual carbon dioxide content in Test No. 1 was 15.4 percent instead of 7.5 percent as reported.[7] Therefore, the dry molecular weight of the gases would have been 30.93 pounds per cubic foot rather than 29.82 pounds per cubic foot. This factor could have introduced an error of no more than 1.8 percent in reported emission levels. EPA relied on measured values as the critical parameters in the Dragon test. The fact that one measured value which was not critical[a] and which is strongly suspect to be in error, would lead to calculated values which disagree with the measured values does not support excluding the Dragon test from consideration of whether the standard can be achieved.

PCA objects that the Oregon Portland Cement plant had an estimated 15 percent of the bags tied off thus creating an unrepresentative operating condition. EPA was faced with the necessity of testing existing Portland cement plants to set a standard for new sources. The record shows that most existing plants were poorly maintained. Although the plant operators had been notified that their plants were going to be source tested for new source performance standards, both the Oregon Portland Cement plant and the Giant Portland Cement plant operations were being operated with holes in their baghouse bags at the time that source testing was scheduled. Abnormalities in their baghouse operation were detected by visible emissions. In both cases, EPA engineers recognized these excessive emissions, stopped the testing, and requested plant maintenance personnel to enter the baghouse and tie off bags that were leaking excessive emissions of dust through holes in the bags.

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[a] As noted on page I-12 of the proposed response to remand order by U.S. Court of Appeals for the District of Columbia, even if Mr. Striker were correct, the particulate emission test results for the maximum test would be 0.22 lbs/ton, 30 percent less than the standard.

In the case of the Oregon Portland Cement plant, it was estimated that 15 percent of the bags were tied off; however, even with this relatively large number of bags tied off, the baghouse control system was capable of being operated (with the kiln in normal operation) within the limits of the proposed mass emission and visible emission standards.

PCA argues further on this point that:

> "Special repairs made for the purpose of this test . . . present an ethical issue similar to the Ford Motor Company maintenance procedures for which Ford was prosecuted. . . ." (PCA Comments, p. 15, note 9).

EPA believes that the ethical distinctions between adjusting equipment at EPA's request and unauthorized tampering with cars undergoing certification tests are self evident.

PCA criticized reliance on the Marquette and Lehigh tests in Maryland because they were performed on new facilities just brought up to production rate. PCA believes that these were ideal, rather than representative, conditions and therefore shouldn't be relied on. It is pointed out that the cover letter from the State of Maryland states that the equipment for both plants was installed new in 1970. The source tests were not conducted until 1972.

Source tests for compliance with new source performance standards will be conducted on new or substantially modified facilities. There is no reason that control equipment cannot be installed, maintained, and operated as necessary to meet the standard long after the plant has been in operation. Tests of the Dragon and Oregon plants confirm this.

PCA argues that EPA did not conduct the source tests on the Marquette and Lehigh plants. They claim EPA shouldn't rely on the report of another agency. The test reports for the Marquette and Lehigh Portland Cement plants were official documents submitted by the companies to a State air pollution control agency. The test reports state that the tests were conducted following EPA test methods and test results indicated compliance with the NSPS. Tests to determine compliance with the standards in question would be conducted in essentially the same manner.

Subsequent to November 26, 1973, the U. S. Environmental Protection Agency has received additional source test data and information indicating that additional Portland cement plant kilns and clinker coolers are capable of being operated in compliance with new source performance standards. It is pointed out that this data and information has not been presented to the petitioners because of the time element involved; however, because of its relevancy, the data are summarized in Table I.

Table I

Test Date	Name of Company	Emissions in Lbs/Ton of Dry Feed
6/25-27/74	United Cement Company[3/] Artesia, Mississippi, kiln, wet process, electrical precipitator	0.209
8-20-74	United Cement Company,[4/] Artesia, Mississippi, clinker cooler, cyclone and wet scrubber.	0.04
5/23-24/74	Santee Portland Cement Company[5/] Holly Hill, South Carolina, kiln, wet process, two electrical precipitators	0.107

Test Date	Name of Company	Emission in Lbs/Ton of Dry Feed
6/12-14/74	Monarch Cement Company [6/] Humboldt, Kansas, kiln No. 4, dry process, baghouse	0.196
6/12-14/74	Monarch Cement Company [6/] Humboldt, Kansas, clinker cooler, No. 4 kiln system, baghouse	0.0174

NORTHWESTERN STATES PORTLAND CEMENT COMPANY COMMENTS

Comments on Affidavit of Mr. Striker

Mr. Striker commented rather extensively on the Orsat analysis used at the Dragon Cement plant test. Both Mr. Striker's comments on this issue and EPA's response[7] are highly technical and are not included here. Copies of both of these documents may be obtained from the Emission Standards and Engineering Division, Research Triangle Park, North Carolina 27711, Attention: Mr. Don R. Goodwin. It will only be noted here that EPA disagrees with Mr. Striker's conclusions. Furthermore, even if Mr. Striker's conclusions were correct, the Dragon test still met the standard as did the tests taken at three other plants, as noted in the text of this response.

Mr. Striker comments as follows: "The standard is inferentially based on the premise that all cement plants are essentially alike although this is not the case. Every plant is custom designed and a unique operation." Nearly every stationary source is a "unique operation". Availability of local materials and local labor force as well as siting and other unique constraints vary with each plant. It would be infeasible and Congress did not intend for EPA to set a different standard for each new Portland cement plant. However, it is the judgment of EPA that all new plants can meet the standard regardless of raw materials used. Control equipment installed to minimize particulate emissions from Portland cement plant kilns are not off-the-shelf type items. Each unit must be carefully engineered and consideration must be given to all variables that can affect the efficient operation of the equipment.

Mr. Striker hasn't shown that the four plants which were found to meet the particulate standard were unique in any respect. Neither has he shown that new plants which install equally effective controls won't meet the standard. Operators have reasonable options in choosing sites and raw materials for new plants. If operators were in fact convinced that there were factors which adversely affected particulate emissions, these could be avoided in the building of new plants.

Mr. Striker claims that independent source tests and summary test data submitted to EPA by Dragon Cement Company are of little value. It is EPA's opinion that summary test data submitted by Dragon Cement Company showing the results of a test conducted independently by the Company which tend to support the standard are of great value. Furthermore, the volume of gases, the dust concentration, and emissions reported in the summary agree favorably with EPA test results.

Mr. Striker believes the Dragon Cement test should be free from all doubts and should stand up under critical inspection from any standpoint. The Dragon Cement results are as free from doubt as almost any other source test. Examination shows that the configuration of the ductwork was not ideal but that EPA modified the sampling procedure as much as possible to offset these conditions. In addition, all reasonable analysis including information and tests supplied by the operating company confirm that the exhaust volume rate is as measured in the EPA test, not the much larger value predicted by Mr. Striker. We believe the operating company is much more knowledgeable of the kiln system than Mr. Striker.

Mr. Striker suggests the Lehigh Portland Cement tests on No. 4 kiln at Union Bridge, Maryland, appear erroneous. Mr. Striker has provided no basis for this conclusion. As in other instances, it appears that estimates were used to make theoretical determinations that do not agree with the measured values. Mr. Striker has submitted no factual information to prove that his determinations are correct.

Comments of Mr. Photiades

Mr. Photiades commented that manufacturer's warranties are limited. The inference of this comment is that such warranties should not be greatly relied on to support the standard. As EPA noted in the text of its response, vendor representations were not of critical importance in supporting the standard. However, since a vendor has a reputation to maintain as well as a financial obligation to meet the strict terms of a warranty, representations of a reputable vendor that its equipment will meet the standard is of some value in supporting the standard even if the warranty of its equipment is limited. Vendors usually limit their warranties not because of doubt about the reliability of the equipment so much as due to the fact that they have no control over operation and maintenance of the equipment.

Mr. Photiades also comments that inflation and other factors have caused prices to increase since the time EPA promulgated the standard. Mr. Photiades cites bids made on a Northwestern baghouse to support his contention. EPA cannot disagree that costs have risen due primarily to inflation over the 1971-1974 period; however, it is also pointed out that the costs of other cement plant components as well as the revenues from the cement sold have likewise risen over the same period.[b/] No information or data have been presented that EPA estimates of costs as shown in the document entitled, "The Financial Impact of Air Pollution Control Upon the Portland Cement Industry" by R. J. Elias and J. M. Dement are grossly in error. The bids made on one baghouse neither prove the study is invalid nor that the standard should be changed, particularly when the normal variability in capital expenditures is considered. It is also important to note that Mr. Photiades did not provide sufficient

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[b/] The average cement price rose from $3.52/bbl in 1971 (Minerals Yearbook, 1972 Edition, page 259) to $5.79/bbl in 1974 (Engineering News-Record, 9-5-74).

detail in his estimate to enable EPA to separate the financial impact resulting from the State Implementation Plans from the impact resulting from new source performance standards.

Comments of Mr. Shepard

Mr. Shepard, counsel for Northwestern criticizes EPA's reliance on the Oregon test because EPA stopped the test until broken bags were tied off. He believes that this prejudiced the test because in his opinion broken bags represent "normal operating procedure" which must be reflected in the test and therefore the standard. He also expressed concern that EPA did not state that tests were not under normal operating procedures until he saw the draft EPA response dated November 26, 1973.

EPA did not and does not consider inadequate maintenance or kiln operation fixed at a lower than normal feed rate as normal operating procedure which must be permitted under the standard. As for Mr. Shepard's comment that he didn't know that EPA discontinued the test until broken bags were tied off, even if that were material he has had an opportunity to comment on this issue as his clients' comments on the draft of this EPA response to the remand were solicited. Indeed he has commented on the issue, so it is not clear how his clients were prejudiced by any alleged failure of EPA to supply information at some point in the past.

Mr. Shepard also suggests that EPA's request to the Oregon operator to tie off its bags is equivalent to Ford Motor Company's unauthorized tampering with cars undergoing Federal pollution control tests for which Ford was fined $7,000,000. As noted earlier in this Appendix (page II-12), the distinction between the activities is self-evident.

APPENDIX III
PORTLAND CEMENT REMAND RESPONSE

PORTLAND CEMENT REMAND RESPONSE: APPENDIX III, PART A: OPACITY STANDARD

In the case of other points at issue in this Remand Response, it has been necessary only to supplement the November, 1973 Draft Response to deal with the comments of the Portland Cement Association and others on that Draft Response. In order to respond fully to the comments with respect to opacity, it has been necessary to prepare the rewritten, extensive response found in this Appendix III. The response contained herein should therefore be considered to supercede that portion of the Draft Response dealing with the opacity standards, and the present Appendix III constitutes the Administrator's full and complete position with regard to this issue.

EPA promulgated opacity limits as well as mass emission limits primarily because EPA believes that opacity limits provide the only effective and practical method for determining whether emission control equipment, necessary for a source to meet the mass emission limits, is continuously maintained and operated properly. It has not been EPA's position that a single, constantly invariant and precise correlation between opacity and mass emissions must be identified for each source under all conditions of operation. Such a correlation is unnecessary to the opacity standard, since the Administrator consistently develops opacity standards for each class of sources at a level no more restrictive than the corresponding mass emission limitation with due consideration given to all conditions

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of operation.[1,2,3] Any source which is meeting the mass limit will therefore also be meeting the opacity limit; if a source is not meeting the opacity limit, this will be due to the failure of that source to properly maintain and operate its emission control equipment. And if the equipment necessary to meet the mass emission standard is not properly maintained and operated, the source will also fail to meet the mass emission standard.

Opacity standards are a necessary supplement to mass emission standards, since there is no reliable instrument to directly measure mass emissions currently available. If only mass emission standards were in effect, operators would not be compelled to assure proper maintenance and operation of pollution control equipment at times other than during periods of performance testing. Two weeks or longer are necessary to schedule a typical stack test, due to the preparation involved. If relatively minor repairs were all that were needed in a given case, such as pump or fan repair or replacement of fabric filter bags, a plant operator could delay such repairs and continue to pollute until shortly before the stack test was conducted. For some types of control equipment, such as scrubbers, the operator could reduce the input of energy (the pressure drop through the system) thereby partially or totally defeating the air pollution control system when stack tests were not being conducted and through such action could release significantly more particulate matter than permissible under the mass emission standards.

Furthermore, stack tests can only be conducted with limited frequency, since they often cost up to $10,000 to perform. Therefore, EPA has required that operators properly maintain and operate air pollution control equipment at all times [40 CFR 60.11(d)] and meet opacity standards at all times except during periods of startup, shutdown, malfunction, and as otherwise provided in the applicable standard [40 CFR 60.11(d)]. Opacity is established as an independent, enforceable standard, rather than merely as an indicator of maintenance and operating conditions, because information regarding those conditions is peculiarly within the control of the operator. The time and expense required to prove that proper procedures have not been followed are so great that the provisions of 40 CFR 60.11(d) by themselves (without opacity standards) would not provide a practical means for ensuring that on a day-to-day basis the pollution control equipment is maintained and operated in the way necessary to meet the mass emission limitations. Opacity standards, in contrast, require only a qualified observer and can be performed with no prior notice. In some cases, of course, a full investigation of operating and maintenance conditions will be desirable. Accordingly, the opacity standards and maintenance requirements were both promulgated, and work in tandem to guarantee that proper maintenance and operation of pollution control equipment, the sine qua non of continuous compliance with emission limits, can in fact be required and monitored.

Two primary aspects of the opacity standards, raised by Petitioner Portland Cement Association, were identified by the Court of Appeals as the bases of its concern: 1) the inherent reliability of opacity standards, i.e. whether measurements of opacity can be made with reasonable accuracy, and 2) the achievability of the opacity standard set for portland cement plants.

RELIABILITY OF OPACITY STANDARDS

Accuracy of Opacity Measurements in Detecting Violations

The Portland Cement Association (PCA) contends that opacity measurements cannot be made with reasonable accuracy. PCA indicates, in particular, that individual observer readings under certain conditions are often in error by 10 percent opacity or more, and therefore that "equivalent opacity--at any level--is an inherently inadequate and invalid measure to determine compliance with, or violation of an anti-pollution law." In support of this contention, PCA argues that observed opacity may be affected by such factors as: dark nights, contaminated water vapor or detached plumes, lack of contrasting background (e.g., white plume viewed against an overcast sky), and wind velocity.

The PCA and other commentators contend also that EPA smoke school requirements and procedures are inadequate to ensure that qualified observers will make accurate readings. The procedure whereby training plumes are shown in advance of certification runs, and under which observers are allowed to use fixed (non-sky) contrasting backgrounds are noted as specific deficiencies.

In response to the questions raised by the Court and the PCA, EPA has reviewed available data concerning the accuracy of qualified observers;[4,5,6] has reviewed the theory of equivalent opacity, particularly concerning the effect of variable viewing conditions on accuracy;[5,6] has reviewed the smoke school certification procedures; and has conducted extensive field tests involving both specially generated plumes and industrial plumes.[7] On the basis of this extensive review, EPA concludes that the accuracy of Reference Method 9 has been well established, that its error tolerance is reasonable and is within limits considered normal by the scientific and engineering community, and that when that error tolerance is accounted for in assessing the results of opacity readings, the method is valid and reliable for determining compliance with prescribed opacity standards. EPA also concludes that the smoke school certification procedures are adequate to assure proper qualification and accuracy of qualified observers. The basis for these conclusions is set forth below.

PCA contends that plumes of the same actual opacity will appear to have somewhat different opacities under dissimilar conditions of viewing. EPA agrees that this is true. A plume will appear most visible to an observer when the plume is viewed against a contrasting background.[5,6] A white plume therefore will be more visible when viewed against a black background or a blue sky than it will when viewed against a hazy or overcast sky.[5] Indeed, a white plume viewed against a white background may well be invisible. PCA concludes that because a plume will appear of lesser opacity under less contrasting conditions, EPA's opacity standards, which limit allowable opacity even under conditions of maximum apparent opacity, are inaccurate and unreliable. It is with this illogical conclusion that EPA disagrees. Cement plant operators are in no way prejudiced by the fact that under less contrasting conditions the opacity of their plume may be read at less than its actual value; obviously, this is to their advantage. Their only real concern, therefore, is with the accuracy of opacity readings under viewing conditions of highest apparent opacity.

Since opacity appears greatest under conditions of high background contrast, it is under such conditions that the potential for positive observer error (observed opacity greater than true opacity) is greatest. This is verified by the available data, which show that positive observer error (average of 25 readings) can approach + 7.5 percent under relatively high contrast conditions such as are encountered at a smoke school, when a training plume is observed against a contrasting background.[4,7] Against a less contrasting background, a plume will be less visible and observer errors will tend to be negative (observed opacity less than true opacity). A collaborative test performed at a power plant where a white plume was observed on an overcast day confirmed that this downward bias can be significant, to the extent that the probability of positive errors even in single readings is essentially non-existent under such conditions.[4]

It is clear therefore that in assessing the reliability of the opacity standards, the possibility of positive errors is of primary concern, since such errors could in theory result in the determination of a violation when true opacity was below the standard. While negative errors are undesirable from an enforcement point of view, they do not place a complying source in jeopardy. It is only necessary therefore to quantify the positive error, which may occur under high contrast viewing conditions, to demonstrate that the method does measure opacity with the reasonable accuracy required of an enforceable standard. As the Court of Appeals notes in Amoco Oil Company v. E.P.A., 501 F2d 722, (6ERC 1481, May 1, 1974, slip op. at pp. 38-39):

> Petitioners also contend that any test methods adopted will involve a certain capacity for statistical error. We fail to appreciate the force of this argument. The possibility of statistical measurement error, which is often unavoidable where regulations set quantitative standards, does not detract from an agency's power to set such standards. It merely deprives the agency of the power to find a violation of the standards, in enforcement proceedings, where the measured departure from them is within the boundaries of probable measurement error. (Emphasis in original.)

The following data provide a basis for such quantification and lead to the conclusion that, using an average of 25 readings obtained under the conditions prescribed in Method 9, qualified observers are able to consistently assign opacity values under relatively ideal conditions, with a positive error seldom exceeding 7.5 percent opacity.[8,9]

(a) October 1973 report titled "Average Observation Error Associated with Smoke Plumes at Levels of Known Opacity".[4] This report in addition to showing that each observer met the ± 7.5 percent requirement, shows that when the readings of all observers are averaged, the largest positive error associated with a given opacity level was 5.0

percent opacity which occurred when the true opacity was 10 percent. For plumes between 15 percent and 90 percent opacity, the average error did not exceed + 2.8 percent opacity. This is a clear demonstration of the inherent accuracy of the technique of determining plume opacity through observation by qualified observers.

(b) In a test conducted November 19-20, 1973, nine qualified observers were shown plumes generated by a smoke generator.[7] The plumes were presented in runs of 25 each during which each observer assigned opacity using the procedures set forth in Method 9. A total of 133 sets of 25 observations using black smoke and 170 sets of 25 observations using white smoke were made. The results of this test are as follows. For white plumes, 99 percent (168 of 170) of the sets of observations were made with an error of less than + 7.5 percent opacity. Ninety-five percent of the sets of observations were made with an error of less than + 5.8 percent opacity. For black plumes, the accuracy was even better: 99 percent of the sets of observations were made with an error of less than + 5 percent opacity; 95 percent were made with an error of less than + 2.7 percent opacity.

(c) A test was conducted at a power plant in Charlotte, North Carolina, on September 30, and October 1, 1974.[7] In this test, 8 qualified observers made a total of 168 sets of 25 observations and assigned opacity according to the procedures of Method 9.* Each run consisted of 25 individual readings. All observers had been certified according to Method 9. Two of the 8 observers had not had previous field experience and two had only limited field experience. The power plant plume (which was monitored with an in-stack transmissometer) was white in appearance and was viewed against a constrasting clear blue sky (no condensed water vapor was present in the plume). The plume was held relatively constant during some runs and was varied during other runs in order to simulate the various conditions which could be encountered in the field. The test results showed that 99 percent (166 of 168) of the observations (average of 25 readings) were made with an error of less than + 6.2 percent opacity; 95 percent with an error of less than + 4.7 percent opacity, and 90 percent with an error of less than + 2.6 percent opacity.

(d) A test was conducted at a sulfuric acid plant on January 29-30, 1974.[7] The plant was equipped with an in-stack transmissometer.**

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* This test was conducted with the 8 observers divided into two groups of 4 each. One group, the control group, made all readings from an optimum viewing location. The second group made readings under differing conditions. Only the readings which were made according to Method 9 criteria are reported here, except that 32 sets of readings are also included which did not conform precisely to Method 9. In these sets, observers were located at an optimum location and assigned opacity in 1 percent increments, not 5 percent increments as specified in the method. The only other data collected but not included in the totals shown here, was read with the sun outside the 140° sector to the observer's back. This is not acceptable under Method 9.

** Not required at sulfuric acid plants by EPA standards.

Observer readings were made according to Method 9 against a contrasting background and were compared with the transmissometer readings. The results are as follows: A total of 298 sets of 25 readings were made. Two sets of readings were made with an average error of + 8 percent opacity. A total of nine sets of readings were made with an average error of + 5 percent opacity or greater. The remaining 289 sets of readings were made with errors of less than + 5 percent opacity.

In summary, a total of 636 runs of 25 readings each were made using white plumes and 133 runs of 25 readings each using black plumes for the specific purpose of quantifying the degree of positive error possible in Method 9. The readings were made against contrasting backgrounds, the condition under which a plume is most visible and is most conducive to positive observer errors. The results show that single observers, on the basis of single sets of 25 readings, are able to assign opacity with errors of less than + 7.5 percent with good consistency (630 of 636 for white plumes; 133 out of 133 for black plumes). Errors in excess of + 7.5 percent can occur, although very infrequently. In short, on the basis of this extensive research of the very sort demanded by PCA, observer readings of opacity have been shown to be within an error tolerance of + 7.5 opacity with a frequency of approximately 99.3 percent (763 of 769 total sets of observations). This indicates clearly that opacity observers do in fact meet the + 7.5 percent opacity accuracy limit which is specified explicitly in the introduction to (amended) Reference Method 9.

Finally with regard to observer accuracy and the inherent reliability of opacity readings, much of the concern of the Court of Appeals is related to PCA's contention, based on an HEW study,[6] that at low levels opacity readings cannot be made reliably. The Court notes[10] that PCA's claim that Table 2 on page 28 of that study shows that the six trained observers rated a plume known to have 0 percent opacity at more than 0 percent opacity, and three rated it at more than 20 percent. The Court notes further that a plume known to be 20 percent opacity was rated higher than 20 percent by five of the six observers, based also on Table 2.

A close reading of Table 2 shows, however, that Petitioners have wholly misconstrued the nature of that test and the data presented in Table 2. In fact, the study specifies that

> "tests of trained observers show that the observers that viewed white plumes on a clear day facing the sun assessed the plumes at a higher Ringelmann number (lower transmittance) than did observers that viewed the plumes with the sun to their backs. For darker, plumes the effect was less pronounced. Group assessments showed good agreement for similar sun-plume-viewer geometries"6 (emphasis added).

EPA agrees that viewing plumes while facing the sun may produce inaccurate readings. It is for this very reason that Reference Method 9[8] requires observations to be made with the sun at the viewer's back.

When Table 2 is examined in this regard, the "good agreement" for apparent similar geometries divides the observers into two groups. The first, consisting of Inspectors 1, 2, and 3, had similar readings among themselves. The second group, consisting of Inspectors 4, 5, and 6, also had good agreement among themselves. The levels of the second group are significantly higher than those of the first group, indicating that the second group was viewing into the sun, while the first group (1, 2, and 3) was viewing with the sun to their backs. This probability is confirmed by the report itself, which states that no restriction was placed on viewing direction.[6] Since only Inspectors 1, 2, and 3 apparently made their observations with the sun at their backs, it is only their results that are at all relevant to the question of observational reliability or accuracy. These results, for the low levels of opacity concerning the Court, are reproduced below:

Table 2. AP-30, Evaluation of White Plumes[6]

In-stack transmittance, percent Equiv. Ring. No.	75% 1.00	90% 0
Insp. No. 1	1.03	0.03
Insp. No. 2	1.13	0.16
Insp. No. 3	0.97	0.17

It is at once apparent that the observations of Inspectors 1, 2, and 3 reflect a very high degree of accuracy, contrary to PCA's contentions. Closer examination of this table, moreover, shows that the data itself is presented in a way not corresponding with EPA's standards. It will be noted that each column is headed by two figures: the "equivalent Ringelmann No." and the "In-stack Transmittance, Percent." Transmittance, of course, represents the percentage of light not blocked by the smoke, so the 75 percent mittance is a 10 percent opacity. As the Court notes,[10] the presently accepted equivalency between Ringelmann numbers and opacity of white smoke is 20:1, i.e. Ringelmann No. 2 = 40 percent opacity, Ringelmann No. 1 = 20 percent opacity, Ringlemann No. .5 = 10 percent opacity, Ringelmann No. 0 = 0 percent opacity, etc. The Table 2 column headings, however, reflect a different equivalency: there, Ringelmann No. 1 corresponds to 25 percent opacity (75 percent transmittance), and Ringelmann 0 corresponds to 10 percent opacity (90 percent transmittance). Since EPA's opacity standards are predicated upon and expressed in terms of the transmission and obscuration of light, it is therefore only the transmittance figures which are at all relevant to evaluating EPA's standards.

The discrepancy between the equivalency used in Table 2 and the presently accepted Ringelmann-opacity equivalency exists because during the middle nineteen-sixties when the data were obtained, there was little interest in reading low opacity plumes, since visible emissions standards were generally at about forty percent opacity. The tests were conducted with smoke readers at a smoke school where the Ringelmann Chart was considered the primary standard, and the school's smoke generator transmissometers were calibrated in terms of Ringelmann numbers (a procedure not used today). This nonlinear calibration resulted in white plumes below thirteen percent opacity being assigned a Ringlemann number of zero. Black plumes below five percent opacity were also assigned a Ringelmann number of zero.[11] It is clear therefore that this equivalency (now replaced by the standard 20:1 ratio) was not intended to deal with low opacity plumes, since all six inspectors in fact reported seeing smoke at what was supposed to be Ringlemann zero.

As a result of these flaws, the data in Table 2 can only be partially converted to opacity percentages for purposes of evaluating observer accuracy and are not completely reliable for this purpose as the observations were not made in accordance with current procedures specified by Method 9. Since a definite ratio of 25:1.00 was used to calibrate the observers at the 25 percent level, those figures can be expressed as opacity percentages. The conversion for the 10 percent opacity column is less exact, but the fact that all observers did observe smoke with a known 10 percent opacity plume allows the use of the standard ratio (Ringelmann .5 = 10 percent opacity) as a close approximation for purposes of conversion. The results of this conversion appear below.

Table 2. AP-30, Evaluation of White Plumes[6]

In-stack transmittance, percent	75%	90%
Opacity, percent	25%	10%
Inspector No. 1		
Ringelmann observed	1.03	0.03
Equivalent opacity	25.75%	0.6%
Inspector No. 2		
Ringelmann observed	1.13	0.16
Equivalent opacity	28.25%	3.2%
Inspector No. 3		
Ringelmann observed	0.97	0.17
Equivalent opacity	24.25%	3.4%

It is apparent from this more properly presented data that Table 2 in fact refutes, rather than supports, PCA's claims of unreliably high readings at low levels of opacity. Indeed, the column which PCA treated as 0 percent opacity is in fact 10 percent opacity; in this column all three inspectors rated the opacity at well below its actual value. Likewise, the column which PCA treated as 20 percent is actually 25 percent opacity. In that column, all observers rated the opacity at values very close to the actual level, and well within the 7.5 percent opacity tolerance to which observers are limited by Method 9.

Because of the fundamental differences in the method of relating and calibrating Ringelmann numbers with equivalent opacity between the method used at the smoke school where the above data were gathered and the present approach used by EPA (as reflected in Method 9), the author of AP-30 states that the data in Table 2 cannot be used to assess the reliability of EPA's method or opacity readings in general.[5] The above discussion is therefore presented solely to demonstrate that, contrary to PCA's belief, those data do not in any way indicate the unreliability of EPA's use of qualified observers. The Agency is not relying on those data as part of its demonstration of the accuracy of Method 9.

In accordance with the Amoco case discussed above, this error tolerance of + 7.5 percent opacity must be accounted for in the enforcement process, so that no source which is in fact in compliance with the applicable opacity standard is cited for a violation due merely to normal observational error. EPA has consistently maintained that it does in fact take this error tolerance into account in the enforcement process. In an earlier draft response to this remand (November, 1973), for example, the Administrator stated that "the agency would not take, and the courts would not sustain, enforcement action based upon opacity observations that do not exceed the standard by more than the average opacity error associated with the particular opacity standard." PCA, however, has been unsatisfied by this assurance, apparently fearing that EPA in its enforcement decisions would ignore the established error tolerance. To provide the certainty desired by PCA and others, EPA is therefore now amending the applicable regulations (40 CFR 60, Appendix A, Reference Method 9) by adding an introductory section which discusses the concept of visible emission readings and describes the effect of variable viewing conditions. This section presents pertinent portions of the above data and notes specifically that the accuracy of the method must be taken into account when determining possible violations of applicable opacity standards. A copy of the revised regulation appears in Part B of Appendix III of this Response.

EPA is also now amending the provisions of Reference Method 9 to make clear that the determination of an opacity level reportable as a violation involves averaging 24 readings taken at 15-second intervals. This will make clear that a single high reading will not be cited as a violation. It will also ensure, as PCA requests, that such individual readings, which may result under normal plant operations from brief events such as shaking of fabric filter bags in baghouses or rapping of electrodes in electrostatic precipitators, will not result in determinations of violation. This amendment to Reference Method 9 is set forth in Part B of Appendix III. (This approach is a satisfactory means of enforcing opacity standards in cases where the violation is a continuing one and time exceptions are not part of the applicable opacity standard. However, the opacity standards for steam electric generators in 40 CFR 60.42 and fluid catalytic cracking unit catalyst regenerators in 40 CFR 60.102 and numerous opacity standards in State Implementation Plans specify various time exceptions. Many State and local air pollution control agencies use a different approach in enforcing opacity standards than the six-minute average period specified in this revision to Method 9. EPA recognizes that certain types of opacity violations that are intermittent in nature require a different approach in applying the opacity standards than this revision to Method 9. It is EPA's intent to propose an additional revision to Method 9 specifying an alternative method to enforce opacity standards. It is our intent that this method specify a minimum number of readings that must be taken, such as a minimum of ten readings above the standard in any one hour period prior to citing a violation. EPA is in the process of analyzing available data and determining the error involved in reading opacity in this manner and will propose this revision to Method 9 as soon as this analysis is completed. The Agency solicits comments and recommendations on the need for this additional revision to Method 9 and would welcome any suggestions particularly from air pollution control agencies in how we might make Method 9 more responsive to the needs of these agencies.)

PCA also contends that the wind velocity during a given set of observations can affect the opacity levels read by observers. EPA agrees that this is true. However, as is the case with lack of contrasting background in viewing a plume, the result of high winds is a negative error in reading the opacity of the plume; this results from the dissipation of the plume caused by the wind. Since a negative error in reading the opacity of the plume cannot prejudice an operator, this consideration is not relevant to the reliability of the method for assessing violations of the opacity standards.

PCA contends that the viewing angle of the observer with respect to the sun and the plume can produce erroneously high readings; if the observer reads the plume while facing the sun, PCA says, such high reading may result. EPA agrees, as was noted above, and for this reason Reference Method 9 has always required the observer to read the plume with the sun at his back. Reference Method 9 is now being amended to include even more specific criteria concerning observer position with respect to the sun. The method will now require that the sun shall be within a 140° sector to the observer's back. This amendment appears in Part B of Appendix III.

The final aspect of opacity observations with which PCA and the Court of Appeals were concerned is the procedure employed by qualified observers to evaluate plumes containing condensed (visible) water vapor, or "steam plumes." When stack emissions contain appreciable water vapor, the vapor becomes visible when the gases are cooled below the dew point and water condenses in fine droplets. Some steam plumes are detached while others are visible as released from the stack.*** However, since ambient air is normally much drier than stack emissions containing visible water vapor, dilution causes the gases at some point to become unsaturated. At this point, condensed water evaporates and is no longer visible in the plume. PCA contends that these plumes cannot be read properly, and the Court of Appeals also notes concern over the way in which steam plumes are to be read. This issue was addressed in part in the report titled "A Report on Contaminated Water Vapor Plumes."[24] As EPA has previously noted, instruction is given in the smoke school as to how such plumes are to be read; the above report illustrates how qualified observers can readily distinguish the point at which all visible water vapor has evaporated from the plume. It is this point at which the opacity reading is made. Since the plume has been somewhat dissipated by that point, the reading is often lower than that which would have been found at the lip of the stack, had the plume been free from visible water vapor. This error is negative, however, and in no way prejudices the plant operator. EPA agrees, however, that the prior language of Method 9 did not sufficiently make this procedure clear. Method 9 is therefore now being amended to remedy that deficiency;

*** The phenomenon of a "detached plume" is often observed when a warm, moist gas stream is released into a cooler atmosphere, e.g. when hot, wet exhaust gases from a wet process kiln are released to the atmosphere. Here the gases are clear at the point of discharge but become opaque as the wet gases mix with cooler air in the atmosphere.

when the new guidelines are adhered to (as they were in the past, though not formally articulated in the Method), any errors due to the presence of water vapor can be eliminated. These amendments appear in Part B of Appendix III.

In addition to proposing specific procedures, EPA is currently investigating techniques which could be employed in the smoke school to further enhance an observer's capability to accurately identify contaminated water plumes. This investigation is being undertaken by a contractor--Pacific Environmental Services, Inc.--and by EPA staff as part of an overall program to develop further guidelines concerning opacity training and field observation.[12] Procedures used by State and local regulatory agencies to observe contaminated water vapor plumes are being reviewed, and the use of such training aids as movies and apprenticeship training will be considered.

The basic question involved is not whether an observer can accurately assign opacity to a contaminated water plume, but rather is whether an observer can distinguish between condensed water vapor and visible particulate matter. To accurately evaluate wet plumes pursuant to revised Method 9, it is necessary only for an observer to distinguish between condensed water vapor and visible particulate air pollutants. In no case is the observer required to assign an opacity to a plume which contains visible (condensed) water droplets.[13]

As noted in the previously cited report, water plumes present an entirely different appearance to an observer than a dust plume. A trained air pollution inspector is familiar with both types of plumes, and has no difficulty distinguishing between the two. While much of his ability in this area stems from smoke school training, his background in inspecting industrial processes is also a factor. Inspectors employed by control agencies are required to become familiar with a broad spectrum of sources and to evaluate opacities from them under all weather conditions. For instance they know which sources employ scrubbers, which cement plants employ wet and dry process systems and generally which sources tend to produce wet plumes. They also know that extreme weather conditions can create visible water plumes at sources which release only negligible particulate matter, e.g. natural gas-fired boilers and water heaters. Thus, when a trained air pollution inspector evaluates a wet plume source he relies on all of this background in making a judgment. In following Method 9 he first identifies that portion of the plume which contains condensed water. As explained in the previously cited report, fluffy water plumes may trail 100 feet or more from the stack.[24] When the water plume disappears, he evaluates the opacity of the remaining dust plume which, if of violating opacity, will persist for a much longer distance. At this point, when water droplets evaporate and cease to be visible, the dust plume has been diluted considerably below the concentration at the stack exit. Only if the dust plume is still of greater than allowed opacity at the point of complete evaporation can an inspector consider a citation of violation. His normal procedure is to enter the plant and evaluate the process operation before in fact issuing the notice of violation. Thus it is obvious that the procedure allows a great deal of latitude to the operator of a wet plume process. Far from citing unjustly for violative visible emissions, the air pollution inspector will often be forced to ignore periods of marginal violations simply because the visible dust plume is masked by visible water droplets.

The revisions in Reference Method 9 make clear that the above procedure is to be followed.[8] For attached steam plumes, the observer is to make his readings at the point where all visible water vapor has evaporated and only particulates remain in the plume. He is to record the reading made at that point in the plume, and is not (as PCA fears) to extrapolate back to any hypothetical value at the lip of the stack. For detached steam plumes, the observer is to read the opacity value as usual at the lip of the stack, providing that no visible water vapor is present there, i.e. providing that there is a gap between the lip of the stack and the point of initial condensation into steam.

EVALUATION OF SMOKE SCHOOL PROCEDURES

The purpose of a smoke school is two-fold. It provides a means for training an observer, and for certifying that an observer is, in fact, capable of making opacity observations with reasonable accuracy. In this sense, the school serves to calibrate (or re-calibrate) observers, and rejects candidates who are not capable of accurately reading opacity. The question of whether the school adequately serves these purposes cannot primarily be answered by examining the procedures used. Rather, it is necessary to examine the accuracy of observers who have been trained and certified in the school, i.e., the results of those procedures. If, as the data discussed earlier demonstrate, qualified observers can read plumes with reasonable accuracy, the procedures and instruction used at the smoke school must, by definition, be accomplishing the desired results.

With regard to PCA's criticism concerning the ability of an observer to accurately read emissions under various field conditions which were not encountered in the training school, it is necessary to refer again to the factors affecting apparent opacity. As discussed above, observations made under conditions of high contrast are most conducive to positive errors. To the extent possible, observers employ contrasting backgrounds during qualification. It is true that this procedure may tend to limit the accuracy of an observer under less than ideal conditions. However, since a plume will present an appearance of lower opacity under such conditions, the resulting bias will be negative. As discussed above, this effect is confirmed by theory and by field observation.

PCA has noted the fact that smoke school trainees are given repeated opportunities to pass the certification test. Thus, an observer may be certified on one run even though the certification criteria were not met on previous runs. Presumably, he could also fail to meet the criteria on subsequent runs. Petitioners are correct in this description--particularly when new or relatively inexperienced persons are being tested. It does not follow, however, that the smoke school procedures are deficient or inadequate in this respect. First, as noted above, the adequacy of the smoke school cannot be determined solely by reviewing the procedures; evaluation can also be made by testing the ability of observers who have passed the certification test. Secondly with respect to the certification procedures, it should be recognized that the ±7.5% criterion is particularly restrictive in that it involves the absolute error, not simply the average taken over 25 readings. Thus, negative and positive errors are not compensating (i.e., a -5% error and a +7 error result in an average absolute error of +6%). This is unlike the field observation procedure where negative and positive errors are compensating (a -5% error and a +7 error result in an average error of +1%). During an EPA smoke school conducted on October 9, 1974, a record was kept for all observers who attended and were certified.[9] This record includes both runs during which the observers passed the certification criteria and during which observers failed to meet the criteria. These data show that even on these runs when observers failed to qualify, over two-thirds of them met

7.5% average error limit imposed by Method 9.[9] Since the Reference Method 9 involves an average of 24 readings as a means of determining plume opacity, failure to continuously meet the more stringent certification requirements is relatively unimportant as long as the average reading is consistently within the prescribed criterion of less than +7.5% average opacity. For example, the requirement that no single reading be missed by more than ±15 percent is somewhat arbitrary, and could be relaxed to ±20 percent to reduce the number of observers failing the certification test. EPA has concluded, however, that the stringent certification criterion serves the intended purpose of forcing a trainee to learn to assign opacity within a reasonable range of precision and therefore should not be relaxed. EPA has further concluded, in summary, that while any changes recommended by the contractor Pacific Environmental Services will be carefully considered, the training program does in fact effectively train observers to read plumes under field conditions with reasonable accuracy.

Summary

EPA believes that the above data have convincingly demonstrated that the opacity standards are inherently reliable.**** The data show that observers can, with a very high confidence level, read plumes to within the certified error tolerance of 7.5%. That tolerance is taken into account in the enforcement process, as provided

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**** A New Jersey court has recently reached the same conclusion. See New Jersey v. LLoyd A. Fry Roofing Co., Docket no. C-3682-72 (Superior Court, Sept. 30, 1974).

explicitly by the (amended) regulations. EPA further believes that the effectiveness of the training program is well proven by the resulting accuracy of its graduates under actual field conditions. In those few situations where the language of the regulations or Reference Method 9 was insufficiently clear or inadequate, those regulations are being or have been amended to remedy such deficiencies. The Administrator concludes, therefore, that since the concerns of the Court of Appeals and the Portland Cement Association in this regard have all been satisfactorily dealt with, the Agency should continue to use opacity standards for new sources under Section 111 of the Clean Air Act. EPA does, however, recognize that some operators of Portland cement plants may install in-stack transmissometers for the purpose of continuous monitoring of particulate emissions.[14] EPA will therefore accept as probative (though not conclusive) evidence the results of such continuous monitoring by transmissometer which indicate that the opacity at the time readings were taken by Reference Method 9 was not in excess of the standard, provided that the source shall meet the burden of proving that the instrument used meets (at the time of the alleged violation) the applicable technical specifications,[14] has been properly maintained and (at the time of the alleged violation) calibrated, and that the resulting data have not been tampered with in any way. The applicable regulations are being amended to reflect this provision and appear in Part B of Appendix III.

EPA will of course continue to review the degree of accuracy and need for opacity measurements as new data and information are acquired. For example, at the request of the Department of Commerce, EPA solicited such information in the preamble to new source performance standards recently proposed (39 FR 37466). However, at this time the data and information available to EPA support the position taken in this response.

ACHIEVABILITY OF THE OPACITY STANDARDS FOR PORTLAND CEMENT PLANTS

Under Section 111 of the Clean Air Act, EPA has established 10 percent opacity as the standard which may not be exceeded by new kilns at Portland cement plants. PCA contends that some new plants will or may be unable to achieve compliance with this visible emissions limit. EPA policy is that opacity limits should be set at such levels that any source which meets the mass emission limits will also meet the opacity limits. EPA has conducted an intensive review of its opacity standards, including conducting new tests and gathering new data, and has concluded that although the 10% opacity standard is achievable by almost all new Portland cement plants, that standard should nevertheless be relaxed to 20% opacity to accomodate certain extreme circumstances. EPA further concludes that at this new level, practical circumstances under which any combination of the factors cited by PCA or the Court as having a possible effect on opacity (transmittance) of smoke plumes that could cause a new source to be unable to meet the opacity standard is exceedingly rare. The reasons for these conclusions are set forth below.

PCA contends that the opacity standards for Portland cement plants are unachievable for two primary reasons, both related to the theory of transmittance of light through a plume. PCA states, first, that opacity varies with particle size and shape, so that a given mass concentration of particles -- which could be composed of various combinations of different size and shape particles -- could result in differing opacities. EPA agrees that this correctly states the theory of plume transmittance (opacity) as it relates to particle dimensions. PCA concludes from this statement of theory, disregarding the results of the application of the theory to operation of Portland cement plants, that such plants might have widely varying opacities while still meeting the mass emission limits. It is with PCA's conclusion that EPA disagrees. The relevant question is what variations in opacity are *in fact* produced by the particle size-shape distributions *actually present* in Portland cement plants under normal operation and with proper maintenance and operation of pollution control equipment. It is this question which is next addressed.

It is known from various studies and experience that uncontrolled gases vented from cement kilns contain heavy concentrations of coarse as well as fine particlate, i.e., in the range of 5 to 15 grains per standard cubic foot.[15] Standards of performance for new sources requiring best available technology, necessitate the installation of high efficiency collectors. Collectors of 99.4 to 99.8 percent efficiency are necessary to reduce exit concentrations to approximately

0.03 grains per standard cubic foot which is necessary to meet the mass emission standard. These collectors, fabric filters or electrostatic precipitators, are more effective in removing coarse particles than fine particles. Thus emissions from collectors, i.e., visible emissions, tend to be made up of much greater fractions of fine particulates than coarse particulates.

In typical high efficiency collector exhaust gases there are generally few particulates larger than 40 microns diameter.[16, 17] The predominant number of particles are between 0.5 and 10 microns with the average size being about 2-4 microns.[2,17] Maximum light scattering is generally acknowledged to be caused by particles in the size range of 0.2 to 2.0 micron.[6,17] Available data indicate that the size distribution of particulates released from well controlled cement kilns are similar within a narrow range (approximately 2 to 6 microns) from one kiln to another, and therfore from one plant to another.[17]

What the above data and studies indicate, in short, is that the size of particles emitted by plants with such control equipment varies only within a very narrow range. This variability in average size is theoretically not sufficient to cause more than a ± 5 percent variation in opacity for typical cement kilns.[6] These data are wholly incompatible with PCA's speculation that widely varying particle sizes might produce much larger variations in opacity at cement plants meeting the mass emission standard.

The shape of particles emitted from well-controlled portland cement plants may vary as PCA contends. However, we disagree with their conclusions that such variations in shape would affect the opacity of emissions perceived by a qualified observer or in-stack transmissometer. Any irregularly shaped particles would be randomly oriented thereby smoothing or averaging out any significant variations of opacity that could possibly result. In addition, it is likely that the particles will be abraded or will condense into spherical shapes for the following reasons: 1) feed materials are ground to less than 75 microns in almost all cases; 2) further attrition and size reduction occurs as the feed material passes through the high temperature rotating kiln; and 3) alkaline material tends to vaporize and condense as a fume.[15,16,17]

Also, the recent microscopic examination of particles from the exhaust gases of a precipitator controlled kiln showed that almost all particles were approximately spherical in shape.[2]

Given that particle size and shape do not vary to the extent necessary to substantiate PCA's speculation, it is apparent that normal operations even from plant to plant will not produce variations sufficient to significantly affect the opacity observed at the point of emission from the stack. Therefore, if the opacity standards are set in accordance with the opacity actually produced by normal operations, then with proper maintenance and operation of control equipment the very slight variations which may occur from plant to plant or from time to time within an individual plant will not cause the source to exceed the opacity standard. And if, for any reasons, some unusual design feature of a given plant caused it to exceed the opacity standard but not the mass emission standard, the variance procedure described below would eliminate any prejudice to such source.

The second major factor which PCA claims affects opacity (transmittance) to the extent that some plants may exceed the opacity standard while meeting the mass emission standard is the diameter of the duct involved; i.e., the path length through which the light must pass. EPA agrees that the greater the path length through which the light must pass, the more light will be attenuated, and the greater will be the opacity. EPA again disagrees, however, with PCA's conclusion, which is again in disregard of the actual circumstances of plant design and operation, that some plants will therefore be unable to meet the opacity standards, though meeting the mass standard. EPA believes that the proper issue in this regard is the actual range of stack diameters resulting from the engineering and economic necessities of plant design. This question is addressed below.

Stack diameter affects opacity directly because it governs the length of the path through which the light is attenuated before it reaches the observer viewing the plume. The larger the diameter of the stack, and therefore the plume, the more light will be attenuated as it passes through the plume, and the greater will be the opacity of the plume. Stacks venting high efficiency control equipment, such as that serving kilns at portland cement plants, are designed to ventilate the process to the degree necessary with the minimum pressure drop and at the lowest cost. These engineering and economic factors result in the construction of stacks in which the gas velocities approximate 30 to 100 feet per second, since at higher velocities friction losses become excessive, necessitating much larger horsepower fans. At lower velocities, the size of the stack required would result in disproportionately large capital costs. Thus, stack diameter tends to be directly related to and characteristic of plant size, varying only within a relatively limited range.

Stack gas exit velocity is controlled by stack diameter. Exit velocity is directly proportional to the volume of gases vented from a kiln and inversely proportional to the cross-sectional area of the stack. For plumes of a given cross-section, velocity has no effect upon opacity, since opacity is a function of path length and is proportional to the concentration and characteristics of particles in the gas stream. The velocity at which the gas stream moves through the viewer's line of vision has no effect on opacity.

It follows, therefore, that an extremely large diameter stack could theoretically be installed at a cement plant, even though its cost would be much greater than normal. In the course of EPA's survey of the cement industry, the largest size kiln stack that has come to our attention is 15 foot in diameter. In the unlikely event that larger stacks were used or other abnormal conditions of design or operation were encountered that could cause a violation of an applicable opacity standard, EPA would evaluate opacity during the performance tests for the mass emission standard. If it were shown necessary, a suitable opacity level greater than

20 percent would be established for that specific kiln installation. Although such an eventuality is highly unlikely, appropriate language is being promulgated in the general provisions of the regulation to accomodate such situations and appears in Part B of Appendix III.

EPA concludes, on the basis of the actual stack diameters employed by the industry, that stack diameter will not cause a plant meeting the mass emission standard to exceed the opacity standard. To deal with the uncertainties cited by PCA as to how plumes from baghouses with stub stacks are to be read, EPA is revising Method 9 to specify that a row of such stub stacks, or any non-circular stack, is to be read along its shortest axis (perpendicular to its longer axis). This ensures that the shorter path length will be used to determine opacity, and will eliminate any concern that a long row of stub stacks, common on baghouses, might be read along its long axis, producing higher opacity.

Given that particle size-shape and stack diameter do not produce opacity variations sufficient to cause a source which might otherwise meet the opacity standard, and which is meeting the mass standard, to exceed the opacity standard, the only remaining issue is whether well-controlled portland cement plants can, in fact, meet the opacity standard. EPA has accumulated data for portland cement plant kilns that are vented to high efficiency control equipment that is properly designed, operated and maintained. These data are summarized in Table I. Opacity readings were also taken of

Table I

Particulate Emissions[2,19-23]

Name of the Company, Date of Test and Type Control Equipment	Test Duration	lbs/ton of dry feed	Stack Dia.	Average Opacity	Max. Single Readin
Dragon Cement Co. Northampton, Pa. 4/29-30/71 Baghouse	6 hours	0.070	11'0"	<10	<10
Oregon Portland Cement Co. Lake Oswego, Oregon 10/7-8/71 Baghouse	6 hours	0.272	4'4" (velocity cone)	<10	<10
Santee Portland Cement Co. Holly Hill, S. C. 5/23-25/74 Electrical Precipitator	8 hours - 2 minutes	0.107	12'0"	0	0
United Portland Cement Co. Artesia, Miss. 6/25-27/74 Electrical Precipitator	8 hours - 23 minutes	0.209	11'3"	<5	<5
Monarch Cement Co. Humboldt, Kansas 6/12-14/74 Baghouse	12.5 minutes	0.196	7'0"	3.8	5
Marquette Cement Co. Neville Island, Pa. 6/19-21/74 Electrical Precipitator	9 hours - 0 minutes	0.339	12'6"	18*	---

*Based on transmissometer data.

several additional well controlled portland cement plant kiln stacks by an EPA contractor.[18] Mass emission tests were not conducted in these instances, however, in light of the petitioners contention that the mass standards are overly restrictive, it would seem unlikely that these plants would be operating significantly below the mass emission standard. A summary of these installations is shown in Table II.

Table II

Opacity of Visible Emissions from Cement Kilns Controlled by Fabric Filters[18]

Name of Company Date of Test and Control Equipment	Duration of Test (hours, min.)	Stack Size (feet)	Average Opacity (percent)	Maximum 6-Minute Average Opacity	Maximum Single Reading
Whitehall Cem Cementon, Pa. 7/29 & 8/1/74 Baghouse	8h 2m	15' dia. (1 stack)	0	0.2	5
Coplay (Egypt) Cement Co. Egypt, Pa. 7/29-31/74 Baghouse	7h 15m	4'10" dia. each. (7 stacks)	0	3.8	5
Hercules Cement Co. Stockerton, Pa. 7/29 & 8/2/74	5h 16m	13' dia. (1 stack)	0	0	0
		2'x1' each. (12 stacks)	0	0	0
Penn-Dixie Cement Co.* Nazareth, Pa. 7/29-30/74 Baghouse	7h 55 m	5'x11' each with center divider. (8 stacks)	10-15	15	25

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*These observations were taken across the shorter axis of the eight stacks (40' pathlength). If the observations had been taken across the longer axis of any one stack, the pathlength would have been 11 feet. The estimated maximum 6-minute average opacity under these latter conditions would be 4.4 percent rather than 15 percent. Likewise, the maximum single reading would be 7.5%. Reference Method 9 now requires these observations to be made across the 11' axis.

With the exception of Marquette Cement Co. all of the kilns identified in Table I were operating below the mass and opacity standards promulgated in 1971 (i.e., 0.3 lb/ton of dry feed and 10%). The data for Marquette Cement Co. indicate that the kiln was not in compliance with the mass emission standard (0.339 versus 0.3 lb/ton of dry feed). The opacity data were collected with an in-stack transmissometer. The stack diameter is 12'6", the average opacity during the mass emission tests was 18%, and the average size of emitted particles was determined to be approximately 2 microns diameter.[2] If the stack diameter were 15', which is the largest diameter stack EPA has observed on cement plants, the average opacity would have been 21%. The mass emission tests for Marquette Cement Co. consisted of three separate runs. The results of the three runs are:

Table III

Opacity and Mass Emissions for a Kiln[2,3]

Run Number	Particulate Emissions, lbs/tons of dry kiln feed	Average opacity (percent) at actual stack conditions (12'6")	Average opacity (percent) extrapolated to 15' diameter stack conditions
1	0.386	22	25
2	0.339	17	20
3	0.292	15	18

The particulate matter emissions from Marquette Cement Co. were analyzed to determine the particle size distribution. This analysis indicated that the average particle diameter was approximately 2 microns which is very low for portland cement plants. These data indicate that for a plant with an unusually large stack diameter and with particulate emissions having very small average particle diameter properties, a 20% opacity standard is more reasonable than a 10% standard. The achievability of a 20 percent standard is amply demonstrated by the data in Tables I and II which illustrate that most portland cement kilns have no difficulty in meeting even a 10 percent opacity standard. The Marquette Cement Company test results illustrate that even under the combination of conditions that would produce the maximum obscuration of light (i.e., large stack diameters, small average particle sizes, and concentrations near the mass emission standard), a 20 percent standard (Table III, run number 3) would be achieved. It should be additionally noted that the combination of conditions for maximum opacity, even though accommodated by the 20 percent standard, will occur infrequently. Therefore, it is concluded that a plant with a 15' diameter stack which meets the mass emission standard will also meet a 20% opacity standard and when it exceeds the mass emission standard will exceed the opacity standard. For stacks smaller than 15 feet in diameter, a portland cement kiln that violates a 20% opacity standard will also violate the mass emission standard by a substantial amount. Data in Table II show that in several cases, opacity of emissions from well controlled cement kilns are appreciably less than 20% even where larger stacks are employed e.g., 0.2% from a 15 foot diamater stack and zero from a 13 foot diameter stack. Based on these data and EPA's policy that opacity standards be established at levels which require proper operation and maintenance of control systems, the opacity standard for portland cement plant kilns is being changed from 10 to 20 percent. This change appears in Part B of Appendix III.

In addition to considerations of the average opacity standards, EPA has evaluated the need for possible time exemptions in the opacity standard. It is recognized that during normal operation of portland cement kilns, process variations, shaking of bags in baghouses, rapping of electrodes in electrical precipitators, etc., can produce mass emissions that are not perfectly constant. It follows that slight variations in opacity can also occur under these conditions. However, with the clarification to Method 9 whereby a minimum of 24 opacity readings must be taken at 15 second intervals over a 6 minute period and with the averaging of observations for determining compliance with the opacity standard, it is apparent that such instantaneous opacity readings will not constitute a violation of the standard. Changing the opacity standard for portland cement kilns from 10 to 20 percent further ensures that such temporary incidents will not cause the opacity standard to be exceeded. Since the change in the opacity standard merely represents a relaxation of the standard, it will be applicable to all sources which commenced construction subsequent to the promulgation of the original, more stringent level. To an even greater degree than the 10% standard, this 20% standard is significantly less stringent than the mass emission limit for portland cement kilns.

As discussed in this remand response, the change of the opacity standard from 10 percent to 20 percent was made to insure that no plant that is meeting the mass emission standard is cited for violating the opacity standard. It does not change the degree of particulate control required of new portland cement plants. Accordingly, this relaxation of the opacity standard does not require an environmental impact statement.

APPENDIX III

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PORTLAND CEMENT REMAND RESPONSE

APPENDIX III, PART B

PREAMBLE AND AMENDMENTS TO REGULATIONS

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Title 40--Protection of the Environment

CHAPTER I--ENVIRONMENTAL PROTECTION AGENCY

Subchapter C--Air Programs

PART 60--STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

Opacity Provisions

On June 29, 1973, the United States Court of Appeals for the District of Columbia in Portland Cement Association v. Ruckelshaus, 486 F. 2d 375 (1973) remanded to EPA the standard of performance for Portland cement plants (40 CFR 60.60 et. seq.) promulgated by EPA under section 111 of the Clean Air Act. In the remand, the Court directed EPA to reconsider among other things the use of the opacity standards. EPA has prepared a response to the remand. Copies of this response are available from the Emission Standards and Engineering Division, Environmental Protection Agency, Research Triangle Park, N. C. 27711, Attn: Mr. Don R. Goodwin. In developing the response, EPA collected and evaluated a substantial amount of information which is summarized and referenced in the response. Copies of this information are available for inspection during normal office hours at EPA's Office of Public Affairs, 401 M Street, S.W., Washington, D. C. EPA determined that the Portland cement plant standards generally did not require revision but did find that certain revisions are appropriate to the opacity provisions of the standards. The provisions promulgated herein include a revision to §60.11, Compliance with Standards and Maintenance Requirements, a revision to the opacity

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standard for Portlant cement plants, and revisions to Reference Method 9. The bases for the revisions are discussed in detail in the Agency's response to the remand. They are summarized below.

The revisions to §60.11 include the modification of paragraph (b) and the addition of paragraph (e). Paragraph (b) has been revised to indicate that while Reference Method 9 remains the primary and accepted means for determining compliance with opacity standards in this part, EPA will accept as probative evidence in certain situations and under certain conditions the results of continuous monitoring by transmissometer to determine whether a violation has in fact occurred. The revision makes clear that even in such situations the results of opacity readings by Method 9 remain presumptively valid and correct.

The provisions in paragraph (e) provide a mechanism for an owner or operator to petition the Administrator to establish an opacity standard for an affected facility where such facility meets all applicable standards for which a performance test is conducted under §60.8 but fails to meet an applicable opacity standard. This provision is intended primarily to apply to cases where a source installs a very large diameter stack which causes the opacity of the emissions to be greater than if a stack of the diameter ordinarily used in the industry were installed. Although this situation is considered to be very unlikely to occur, this provision will accommodate such a situation. The provision could also apply to other situations where for any reason an affected facility could fail to meet opacity standards while meeting mass emission standards, although no such situations are expected to occur.

A revision to the opacity standard for Portland cement plants is promulgated herein. The revision changes the opacity limit for kilns from 10 percent to 20 percent. This revision is based on EPA's policy on opacity standards and the new emission data from Portland cement plants evaluated by EPA during its reconsideration. The preamble to the standards of performance which were promulgated on March 8, 1974 (39 FR 9308) sets forth EPA's policy on opacity standards: (1) opacity limits are independent enforceable standards; (2) where opacity and mass/concentration standards are applicable to the same source, the mass/concentration standards are established at a level which will result in the design, installation, and operation of the best adequately demonstrated system of emission reduction (taking costs into account); and (3) the opacity standards are established at a level which will require proper operation and maintenance of such control systems. The new data indicate that increasing the opacity limit for kilns from 10 percent to 20 percent is justified, because such a standard will still require the design, installation, and operation of the best adequately demonstrated system of emission reduction (taking costs into account) while eliminating or minimizing the situations where it will be necessary to promulgate a new opacity standard under §60.11(e).

In evaluating the accuracy of results from qualified observers following the procedures of Reference Method 9, EPA determined that some revisions to Reference Method 9 are appropriate. The evaluation showed that observers trained and certified in accordance with the procedures prescribed under Reference Method 9 are consistently able to read opacity with errors not exceeding +7.5 percent based upon single sets of the average of 24 readings. The revisions to Reference Method 9 include the following:

1. An introductory section is added. This includes a discussion of the concept of visible emission reading and describes the effect of variable viewing conditions. Information is also presented concerning the accuracy of the method noting that the accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

2. Provisions are added which specify that the determination of opacity requires averaging 24 readings taken at 15-second intervals. The purpose for taking 24 readings is both to extend the averaging time over which the observations are made, and to take sufficient readings to insure acceptable accuracy.

3. More specific criteria concerning observer position with respect to the sun are added. Specifically, the sun must be within a 140° sector to the observer's back.

4. Criteria concerning an observer's position with respect to the plume are added. Specific guidance is also provided for reading emissions from rectangular emission points with large length to width ratios, and for reading emissions from multiple stacks. In each of these cases, emissions are to be read across the shortest path length.

5. Provisions are added to make clear that opacity of contaminated water or steam plumes is to be read at a point where water does not exist in condensed form. Two specific instructions are provided:

one for the case where opacity can be observed prior to the formation of the condensed water plume, and one for the case where opacity is to be observed after the condensed water plume has dissipated.

6. Specifications are added for the smoke generator used for qualification of observers so that State or local air pollution control agencies may provide observer qualification training consistent with EPA training.

In developing this regulation we have taken into account the comments received in response to the September 11, 1974 (39 FR 35852) notice of proposed rulemaking which proposed among other things certain minor changes to Reference Method 9. This regulation represents the rulemaking with respect to the revisions to Method 9.

The determination of compliance with applicable opacity standards will be based on an average of 24 consecutive opacity readings taken at 15 second intervals. This approach is a satisfactory means of enforcing opacity standards in cases where the violation is a continuing one and time exceptions are not part of the applicable opacity standard. However, the opacity standards for steam electric generators in 40 CFR 60.42 and fluid catalytic cracking unit catalyst regenerators in 40 CFR 60.102 and numerous opacity standards in State implementation plans specify various time exceptions. Many State and local air pollution control agencies use a different approach in enforcing opacity standards than the six-minute average period specified in this revision to Method 9. EPA recognizes that certain types of opacity violations that are intermittent in nature require a different approach in applying the opacity standards than this revision to Method 9. It is EPA's intent to propose an additional revision to Method 9 specifying an alternative method to enforce opacity standards. It is our intent that this method specify a minimum number of readings that must be taken, such as a minimum of ten readings above the standard in any one hour period prior to citing a violation. EPA is in the process of analyzing available data and determining the error involved in reading opacity in this manner and will propose this revision to Method 9 as soon as this analysis is completed. The Agency solicits comments and recommendations on the need for this additional revision to Method 9 and would welcome any suggestions particularly from air pollution control agencies on how we might make Method 9 more responsive to the needs of these agencies.

These actions are effective on (date of publication). The Agency finds good cause exists for not publishing these actions as a notice of proposed rulemaking and for making them effective immediately upon publication for the following reasons:

(1) Only minor amendments are being made to the opacity standards which were remanded.

(2) The U. S. Court of Appeals for the District of Columbia instructed EPA to complete the remand proceeding with respect to the Portland cement plant standards by November 5, 1974.

(3) Because opacity standards are the subject of other litigation, it is necessary to reach a final determination with respect to

the basic issues involving opacity at this time in order to properly respond to this issue with respect to such other litigation.

These regulations are issued under the authority of sections 111 and 114 of the Clean Air Act, as amended (42 U.S.C. 1857c-6 and 9).

Date — Administrator

Part 60 of Chapter I, Title 40 of the Code of Federal Regulations is amended as follows:

1. Section 60.11 is amended by revising paragraph (b) and adding paragraph (e), reading as follows:

* * * * *

(b) Compliance with opacity standards in this part shall be determined by conducting observations in accordance with Reference Method 9 in Appendix A of this part. Opacity readings of portions of plumes which contain condensed, uncombined water vapor shall not be used for purposes of determining compliance with opacity standards. The results of continuous monitoring by transmissometer which indicate that the opacity at the time visual observations were made was not in excess of the standard are probative but not conclusive evidence of the actual opacity of an emission, provided that the source shall meet the burden of proving that the instrument used meets (at the time of the alleged violation) Performance Specification 1 in Appendix B of this part, has been properly maintained and (at the time of the alleged violation) calibrated, and that the resulting data have not been tampered with in any way.

* * * * *

(e)(1) An owner or operator of an affected facility may request the Administrator to determine opacity of emissions from the affected facility during the initial performance tests required by §60.8.

(2) Upon receipt from such owner or operator of the written report of the results of the performance tests required by §60.8, the Administrator will make a finding concerning compliance with opacity and other applicable standards. If the Administrator finds that an affected facility is in compliance with all applicable standards for which performance tests are conducted in accordance with §60.8 of this part but during the time such performance tests are being conducted fails to meet any applicable opacity standard, he shall notify the owner or operator and advise him that he may petition the Administrator within 10 days of receipt of notification to make appropriate adjustment to the opacity standard for the affected facility.

(3) The Administrator will grant such a petition upon a demonstration by the owner or operator that the affected facility and associated air pollution control equipment was operated and maintained in a manner to minimize the opacity of emissions during the performance tests; that the performance tests were performed under the conditions established by the Administrator; and that the affected facility and associated air pollution control equipment were incapable of being adjusted or operated to meet the applicable opacity standard.

(4) The Administrator will establish an opacity standard for the affected facility meeting the above requirements at a level at which the source will be able, as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source is meeting the mass or concentration emission standard.

The Administrator will promulgate the new opacity standard in the Federal Register.

2. In §60.62, paragraph (a)(2) is revised to read as follows:

§60.62 Standard for particulate matter

* * * * *

(a) * * *

(2) Exhibit greater than 20 percent opacity.

3. Appendix A--Reference Methods is amended by revising Reference Method 9 as follows:

METHOD 9--VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES

Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume. This method involves the determination of plume opacity by qualified observers. The method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of plume opacity. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer, and can affect the ability of the observer to accurately assign opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. It follows from this, and is confirmed by field trials, that the opacity of a plume, viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100% of the sets were read with a positive error* of less than 7.5% opacity; 99% were read with a positive error of less than 5% opacity.

(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99% of the sets were read with a positive error of less than 7.5% opacity; 95% were read with a positive error of less than 5% opacity.

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*For a set, positive error = average opacity determined by observer's 25 observations - average opacity determined from transmissometer's 25 recordings.

The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

1. Principle and applicability.

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to §60.11(b) and for qualifying observers for visually determining opacity of emissions.

2. Procedures. The observer qualified in accordance with paragraph 3 of this method shall use the following procedures for visually determining the opacity of emissions:

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his line of vision is approximately perpendicular to the plume direction, and when observing opacity of emissions from rectangular outlets (e.g. roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g. stub stacks on baghouses).

2.2 Field records. The observer shall record the name of the plant, emission location, type facility, observer's name and affiliation, and the date on a field data sheet (Figure 9-1). The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded on a field data sheet at the time opacity readings are initiated and completed.

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached steam plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached steam plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9-2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9-1 for an example.)

3. Qualifications and testing.

3.1 Certification requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and an average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in paragraph 3.2. Smoke generators used pursuant to paragraph 3.2 shall be equipped with a smoke meter which meets the requirements of paragraph 3.3.

The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any observer in order to retain certification.

3.2 Certification procedure. The certification test consists of showing the candidate a complete run of 50 plumes--25 black plumes and 25 white plumes--generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke generator specifications. Any smoke generator used for the purposes of paragraph 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display in-stack opacity based upon a pathlength equal to the stack exit diameter, on a full 0 to 100 percent chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 9-1. The smoke meter shall be calibrated as prescribed in paragraph 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 9-1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

TABLE 9-1 SMOKE METER DESIGN AND PERFORMANCE SPECIFICATIONS

Parameter	Specification
a. Light source	Incandescent lamp operated at nominal rated voltage
b. Spectral response of photocell	Photopic (Daylight spectral response of the human eye--reference 4.3)
c. Angle of view	15° maximum total angle
d. Angle of projection	15° maximum total angle
e. Calibration error	± 3% opacity, maximum
f. Zero and span drift	± 1% opacity, 30 minutes
g. Response time	≤ 5 seconds

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warmup by alternately producing simulated opacity of 0 percent and 100 percent. When stable response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent readings are produced without adjustment. Simulated 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

3.3.2 Smoke meter evaluation. The smoke meter design and performance are to be evaluated as follows:

3.3.2.1 Light source. Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within ± 5 percent of the nominal rated voltage.

3.3.2.2 Spectral response of photocell. Verify from manufacturer's data that the photocell has a photopic response; i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 9-1.

3.3.2.3 Angle of view. Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15°. The total angle of view may be calculated from: $\theta = 2 \tan^{-1} d/2L$, where θ= total angle of view; d = the sum of the photocell diameter + the diameter of the limiting aperture; and L = the distance from the photocell to the limiting aperture. The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters this is normally an orifice plate.

3.3.2.4 Angle of projection. Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15°. The total angle of projection may be calculated from: $\theta = 2 \tan^{-1} d/2L$, where θ = total angle of projection; d = the sum of the length of the lamp filament + the diameter of the limiting aperture; and L = the distance from the lamp to the limiting aperture.

3.3.2.5 Calibration error. Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter according to 3.3.1 and then inserting a series of three neutral-density filters of nominal opacity of 20, 50, and 75 percent in the smoke meter pathlength. Filters calibrated within ±2 percent shall be used. Care should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum error on any one reading shall be 3 percent opacity.

3.3.2.6 Zero and span drift. Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

3.3.2.7 Response time. Determine the response time by producing a series of five simulated 0 percent and 100 percent opacity values and observing the time required to reach stable response. Opacity values of 0 percent and 100 percent may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

4. References.

4.1 Air Pollution Control District Rules and Regulations, Los Angeles County Air Pollution Control District, Regulation IV, Prohibitions, Rule 50.

4.2 Weisburd, Melvin I., Field Operations and Enforcement Manual for Air, U. S. Environmental Protection Agency, Research Triangle Park, N. C., APTD-1100, August 1972, pp. 4.1-4.36.

4.3 Condon, E. U., and Odishaw, H., Handbook of Physics, McGraw-Hill Co., N. Y., N. Y., 1958, Table 3.1, p. 6-52.

COMPANY________________________
LOCATION________________________
TEST NUMBER________________________
DATE________________________
TYPE FACILITY________________________
CONTROL DEVICE________________________

HOURS OF OBSERVATION________________________
OBSERVER________________________
OBSERVER CERTIFICATION DATE________________________
OBSERVER AFFILIATION________________________
POINT OF EMISSIONS________________________
HEIGHT OF DISCHARGE POINT________________________

CLOCK TIME	Initial			Final
OBSERVER LOCATION Distance to Discharge				
Direction from Discharge				
Height of Observation Point				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, % clouds, etc.)				
PLUME DESCRIPTION Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY

Set Number	Time	Opacity	
	Start--End	Sum	Average

Readings ranged from ____ to ____ % opacity

The source was/was not in compliance with ____ at the time evaluation was made.

FIGURE 9-2 OBSERVATION RECORD

PAGE ___ OF ___

COMPANY ____________________
LOCATION ____________________
TEST NUMBER ____________________
DATE ____________________

OBSERVER ____________________
TYPE FACILITY ____________________
POINT OF EMISSIONS ____________________

Hr.	Min.	Seconds				STEAM PLUME (check if applicable)		COMMENTS
		0	15	30	45	Attached	Detached	
	0							
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
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FIGURE 9-2 OBSERVATION RECORD (Continued) PAGE ___ OF ___

COMPANY ____________
LOCATION ____________
TEST NUMBER ____________
DATE ____________

OBSERVER ____________
TYPE FACILITY ____________
POINT OF EMISSIONS ____________

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
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